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PNL-4435

UC-95d

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Pacific Northwest Laboratory
Operated for the U.S. Department of Energy
by Battelle Memorial Institute

Battelle

PNL-4435

PACIFIC NORTHWEST LABORATORY
operated by
BATTELLE
for the
UNITED STATES DEPARTMENT OF ENERGY
under Contract DE-AC06-76RLO 1830

Printed in the United States of America
Available from
National Technical Information Service
United States Department of Commerce
5285 Port Royal Road
Springfield, Virginia 22151

NTIS Price Codes
Microfiche A01

Printed Copy

Pages	Price Codes
001-025	A02
026-050	A03
051-075	A04
076-100	A05
101-125	A06
126-150	A07
151-175	A08
176-200	A09
201-225	A010
226-250	A011
251-275	A012
276-300	A013

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CLIMATE SELECTION AND DEVELOPMENT OF CLIMATE INDICATORS

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CONTENTS

I. EXECUTIVE SUMMARY

This report documents a climate analysis procedure that selects climate locations encompassing the whole range of variation in climate conditions in the continental United States.

The results of this procedure are designed to be used in energy analysis projects of commercial buildings (including multifamily residences), single family residences and mobile homes.

The overall objectives of this climate selection process are:

- For each building category, select a set of climate locations which will "bound" the national variation in climate factors relevant to building energy use.
- Rank such climate locations to permit using the fewest possible locations in the subsequent energy analyses of the buildings.
- The methodology should guarantee the smallest possible variance of the predicted building energy performance at other locations throughout the country.

The basic selection process relies on the construction of regression experimental design models using as data input climate indicators derived from Building Balance Points.

Balance points allow for a proper accumulation of the measures being proposed. They are defined for both dry bulb temperature and humidity. The cumulative value of any given indicator for heating or cooling will be determined by the balance point responding to the thermal profile of the building type being analyzed.

The factors selected from the pool of variables determining the building hourly loads were dry bulb temperature, humidity, wind speed and insolation. All climate indicators describing these factors are TRY cumulative statistics derived from hourly data (the same exact data driving the building loads). These are:

- Heating Degree Hours
- Cooling Degree Hours
- Heating Humidity Ratio Hours
- Cooling Humidity Ratio Hours
- Heating Insolation Hours
- Cooling Insolation Hours
- Heating Wind Hours
- Cooling Wind Hours

The experimental design is constructed from a starting set of locations to which cities are added, or exchanged, utilizing add or exchange algorithms which are part of a user interactive routine called ADDEXC.

Sensitivity tests for the selection were performed with respect to the prototype configuration in each building category, the hypothesized regression models and the selected starting set of locations.

The results of this selection process are shown in Table E.1.

TABLE E.1

FINAL CLIMATE SELECTIONS

Commercial Multifamily Buildings	Single Family Residences	Mobile Homes
Albuquerque	Burlington	Phoenix
Bismarck	Lake Charles	Miami
El Paso	Phoenix	Albuquerque
Great Falls	Cheyenne	San Diego
San Francisco	Brownsville	Atlanta
Miami	San Diego	Lake Charles
Phoenix	Oklahoma City	Seattle
Lubbock	Great Falls	Bismarck
Cheyenne	Bismarck	Washington, DC
Seattle	Salt Lake City	Anchorage
Los Angeles	San Francisco	
Oklahoma City	Miami	
Burlington	Seattle	
Lake Charles	El Paso	
Salt Lake City	Fresno	
Omaha	Richmond	
Portland, ME	Lubbock	
Brownsville	Medford	
Minneapolis	Aubuquerque	
Madison	Los Angeles	

As can be observed, the experimental design building process does not yield a sample which is stratified according to climate zones. Instead, the selected points represent extreme climate conditions. This is because the larger the spread of the independent variable observations, the smaller the variance of the regression coefficients.

No intermediate climates are required if the relationships of the type described in the various linear models used accurately depict the relationship between building designed energy consumption and the climate indicators developed for the analyses. Bearing in mind this caveat, this experimental design selection process yields minimized variability for the estimated regression coefficients.

II. INTRODUCTION

A. Background

This report documents a climate analysis procedure for selecting climate locations which would represent the variation in climate conditions throughout the United States. Weather data for the climate locations selected have been used in computer simulations of the annual energy performance for typical or prototypical building designs.

Separate energy analysis projects for three building categories were to use the results of this climate location project. The three building categories are:

- Commercial buildings (including multifamily residences)
- Single family residences
- Mobile homes

At this point in time, the climate locations selected by the procedure have been used to analyze the impacts of climate variations for Mobile Homes (Ref. 1), are currently being used for Single Family Residences, and may be used for planned future analysis of commercial buildings, including analysis of ASHRAE Standard 90X.

This climate analysis has been conducted in the context of specific energy analysis objectives, discussed in the next section. Also, this analysis can be viewed in the context of previous climate analyses conducted as part of research for the Building Energy Performance Standards (BEPS) program. (See Refs. 2, 3). This analysis builds upon results from several of these previous studies, as well as other building energy related research.

B. Report Organization

The same overall Experimental Design method has been used for the climate location selections for three building categories: (1) commercial, (2) single family residential, and (3) mobile homes. However, the specific application of the methodology differed for each building category.

Therefore, this report first describes the <u>overall</u> objectives, approach, and method used for all three categories (Sections III, IV and V). Next, the specific application of the general method to each building category is discussed in sequence:

- Commercial Multifamily Climate Selection (Section VI)

- Residential Climate Selection (Section VII)

- Mobile Home Climate Selection (Section VIII)

The climate selection results, conclusions, recommendations and limits for each building category are presented within the description of the application of the method for that category.

An overall constraint on this climate selection analysis is that the climate data to be used would be the Test Reference Year (TRY) data for each available location (per DOE decision). Climate data was available for 60 climate locations, and this data was used as the basis for the analysis.

III. OBJECTIVES

The overall objectives of this climate location selection process are:

- For each building category, select a set of climate locations which will "bound" the national variation in climate factors important to building energy use.

- Rank the climate locations selected to permit using the fewest possible locations in the subsequent energy analyses of the buildings.

- The method should permit reasonably accurate predictions of the energy performance of the buildings at other locations throughout the country (e.g., via regression analyses), given the climate data at these locations.

Computer simulations of energy use tend to be expensive, especially if many locations are involved to capture the impacts of climate variation. Therefore, the intent of this selection procedure is to be as efficient and cost effective as possible, i.e., to capture the significant national variations in temperature, humidity, insolation and wind with the least possible number of locations.

In this context, another objective of this climate analysis is to select climate indicators to capture key energy-related variations in climate and then "explain" a large portion of energy use changes for the "same" buildings, with changes in climate (say, Minneapolis vs. Dallas, etc.)

Ultimately these climate locations and the climate indicators developed are intended to be used to specify regression models for interpolating the energy results from the locations analyzed to other locations in the country. However, the generation of regression estimates is not part of this report.

IV. APPROACH

An "Experimental Design" approach using balance point climate indicators as data input has been selected for this analysis. This approach enables us to perform two operations:

1. Extract climate measures reflective of a building's thermal behavior by presimulating in a simplified way the computer code used to generate the prototype's energy results.

2. Use statistical criteria to systematically select the energy analysis locations in the country that best represent the various possible combinations among climate variable ranges. This requires an "a priori" specification of regression models to explain the variations in simulated energy consumption.

This approach tends to select climate locations with extreme values for the climate variables being considered. A major benefit of this approach is that a full range of climate variation throughout the country can be examined through the analysis of relatively few climate locations. This makes the approach very cost-effective from the point of view of analyzing climate impacts with the fewest number of climate locations, thus reducing total computer runs required.

One can then interpolate, from the results of the climate locations analyzed, to other climate locations with more moderate climate conditions for the variables being considered; namely, indicators of temperature, humidity, solar and wind. This approach assumes that the relationship between building energy performance and the climate variables will be approximately linear from the climate extremes to the more moderate values.

Some effort to test this assumption is possible from the results of the single family residential analysis being conducted. That analysis is studying building energy performance on DOE 2 for both the extreme climate locations selected from this approach, plus several climate locations with more moderate climate locations. Therefore, energy predictions for the more moderate climate locations from climate/energy regression models under steady state assumptions can be compared with the energy results from DOE 2 for these same locations. However, the results of such analysis are not part of this report. This report documents only the selection of the climate locations, not the results of computer-based energy analyses which have used or will use these climate locations.

An important consequence of this approach for choosing climate locations is that the climate locations selected are not necessarily typical of climate regions or of climate zones. This is an important distinction between this climate selection procedure and other climate studies which have selected climate locations representing typical climate conditions within geographical regions or within climate zones.

An alternative approach could have been to use a Cluster Analysis. This technique groups climate locations into subgroups according to their similarily in climate and could as well use building specific data as input. The Cluster Analysis approach tends to select climate locations which represent "typical" climate conditions for climate regions or climate zones. Thus, a Cluster Analysis technique selects a set of climate locations which represent other locations with similar climate conditions.

There are several limitations of a Cluster Analysis approach which make it less efficient than an Experimental Design approach in terms of total cost-effectivenss of the analysis:

- The number of climate zones or regions is fixed, and is usually not a variable in the analysis. The cluster analysis approach does not attempt to minimize the number of climate locations while at the same time assuring a reasonable predictive ability for climate variation relative to building energy use.

- There is no direct connection in the clustering analysis approach between the climate locations selected and the predictive value of these locations for estimating building energy use in other climate locations.

Because of these limitations of the Cluster Analysis approach, the experimental design approach was chosen because it has the full potential to provide ranked subsets of varying size and its main purpose is to maximize the prediction value of the computer-based energy analysis results to any other location in the country for which climate data is available that is similar to that used for the locations in the analysis. The selected climate locations as such are not so important as their ability to be used to generalize to other locations with controlled statistical levels of confidence.

In addition to climate there are other significant sources of regional and local variation in energy and cost effectiveness from location to location. These are:

- Construction practices

- Usage of fuels and HVAC systems
- Construction costs
- Fuel prices and escalation rates

The variations due to construction practice, fuels used, and HVAC systems will be addressed in the energy analysis of each building type. The variations due to cost and price differentials will be addressed independently of the energy analaysis in subsequent economic analyses.

It is anticipated that variations in fuel prices, etc., will be in many cases more significant than climate variations. The approach used here will permit isolating the magnitude of the climate variation from these other sources.

A description of the procedure used to establish the Experimental Design for selecting the climate locations follows.

V. METHOD

This section provides a description of the climate selection methodology and data inputs.

The basic selection process relies on the construction of regression equation based on an experimental design model using as data input climate indicators derived from building prototypes balance points.

The heating "balance point" for a building is that temperature below which energy from the heating system is required to maintain the inside temperature to make up for heat losses to colder air outside. In general, the heating balance point gets lower as the following factors occur:

1. The building gets "tighter" - more insulation, less infiltration/outside air.
2. Internal loads increase - more heat is generated inside the envelope from people, appliances or lights.

The cooling balance point can be different (higher) than the heating balance point, since summer indoor set points and ventilation levels are higher than during the winter.

Data inputs were TRY cumulative measures for heating and cooling dry bulb temperature, humidity ratio, insolation and wind speed for 60 locations.

The steps covered in this process are as follows:

- Construction of regression experimental design models
- Development of climate indicators
- Algorithm development

A. Construction of Regression Experimental Design Models

The basic premise is that it is possible to develop a set of climate indicators which can be related to building energy consumption by a simple functional form. The purpose of specifying the indicators and the relationship is not to accurately predict actual energy consumption but to express the relationship between climate and energy consumption in a simple and useful form. At best the model envisioned identified general characteristics of the relationship. This allows the simple model to be used to select a limited number of climate locations for detailed examination while ensuring that appropriate combinations of climate locations are examined.

The construction of a regression model involves the selection of the climate indicators (discussed subsequently) and the specification of the model form. The primary regression model considered includes eight climate indicators in a linear relationship, i.e.,

$$E = a_0 + a_1C_1 + a_2C_2 + a_3C_3 + a_4C_4 + a_5H_5 + a_6H_6 + a_7H_7 + a_8H_8 + e$$

where E is the energy budget

a_0, a_1, ...a_8 are unknown regression coefficients

C_1, C_2, C_3, C_4 are cooling climate indicators

H_5, H_6, H_7, H_8 are heating climate indicators

e is unknown error associated with using the model to predict energy budget levels.

The form of the regression model and the indicators included are based on past studies and a priori beliefs.

Since the model is not known with certainty in the applications that follow, a number of different models are specified. Each model is used in the climate location selection process to guard against over dependence on a specific model. The model is used as a vehicle for climate location selection and nothing more. After detailed energy budget calculations (e.g., by DOE 2) are performed for multiple climate locations, a specific regression model could be developed to relate the effect of climate to energy budgets. That is not the purpose of the current regression model.

After the specification of the model form and the climate indicators, the experimental design portion of the climate location selection process is implemented. A candidate set of locations is necessary for the process. For the current study the locations are 60 cities with TRY data readily available. The specific cities are given in Table 5.1. The cities cover the continental United States geographically. It is assumed the locations cover the range of climate conditions present in the United States. If circumstances had permitted, a more complete set of locations with TRY data would have been used.

The purpose of the experimental design procedure is to select a subset of the candidate cities that would enable a "good" fit of the regression model to be completed based on as few cities as possible. There would be no need for this step if all candidate cities could be used.

An interactive computer program ADDEXC is used to

TABLE 5.1

CANDIDATE TRY CITIES

WBAN NUMBER	CODE NAME	City
03927	FORTWO	Fort Worth, TX
03937	LAKECH	Lake Charles, LA
03940	JACK/MS	Jackson, MS
12839	MIAMI	Miami, FL
12842	TAMPA	Tampa, FL
12916	NEWORL	New Orleans, LA
12918	HOUSTON	Houston, TX
12919	BROWNSV	Brownsville, TX
12921	SANANT	San Antonio, TX
13722	RALEIGH	Raleigh, NC
13737	NORFOLK	Norfolk, VA
13739	PHILADE	Philadelphia, PA
13740	RICHMON	Richmond, VA
13743	WASHING	Washington, DC
13874	ATLANTA	Atlanta, GA
13876	BIRMING	Birmingham, AL
13880	CHARLES	Charleston, SC
13889	JACK/FL	Jacksonville, FL
13893	MEMPHIS	Memphis, TN
13987	NASHVIL	Nashville, TN
13967	OKLAHOM	Oklahoma, OK
13968	TULSA	Tulsa, OK
13983	COLUMBI	Columbia, MO
13985	DODGEC	Dodge City, KS
13988	KANSAS	Kansas City, MO
13994	STLOUI	St. Louis, MO
14732	NEWYOR	New York, NY
14733	BUFFALO	Buffalo, NY
14735	ALBANY	Albany, NY
14739	BOSTON	Boston, MA
14743	BURLING	Burlington, VT
14764	PORT/ME	Portland, ME
14819	CHICAGO	Chicago, IL
14820	CLEVELA	Cleveland, OH
14837	MADISON	Madison, WI
14922	MINNEAP	Minneapolis, MN
14942	OMAHA	Omaha, NE
23042	LUBBOCK	Lubbock, TX
23044	ELPASO	El Paso, TX
23047	AMARILL	Amarillo, TX

TABLE 5.1 (Cont.)

WBAN NUMBER	CODE NAME	CITY
23050	ALBUQUE	Albuquerque, NM
23174	LOSANG	Los Angeles, CA
23183	PHOENIX	Phoenix, AZ
23188	SANDIE	San Diego, CA
23232	SACRAME	Sacramento, CA
23234	SANFRA	San Francisco, CA
24011	BISMARC	Bismarck, ND
24018	CHEYENE	Cheyenne, WY
24127	SALTLA	Salt Lake City, UT
24131	BOISE	Boise, ID
24143	GREATF	Great Falls, MT
24225	MEDFORD	Medford, OR
24229	PORT/OR	Portland, OR
24233	SEATTLE	Seattle-Tacoma, WA
93193	FRESNO	Fresno, CA
93814	CINCINN	Cincinnati, OH
93819	INDIANA	Indianapolis, IN
93821	LOUISVI	Louisville, KY
94323	PITTSBU	Pittsburgh, PA
94847	DETROIT	Detroit, MI

construct the optimum regression experimental design. The design is optimum (for a certain design size) in the sense that the design points (i.e., cities) are tailored to the regression model of interest according to a chosen design criteria.

ADDEXC constructs regression experimental designs from the set of 60 TRY candidate cities. To begin a regression model, a starting subset of the candidate cities is specified. Two options for choosing the starting design (cities) are used:

- User specified set of n cities
- n randomly selected cities

Once the starting design is chosen, the design building proceeds by one of two operations:

- Add a city to the design from candidate set
- Exchange an existing design city for another city from the remaining candidate cities.

These two operations are performed repeatedly and may be interchanged with one another. Typically, the process is started with n cities followed by the exchange option to find the "best" n cities. Additional cities are added to improve the properties of the design and then the exchange option is used to determine whether a better set exists for the new size.

The choice of the candidate city to add or exchange into the design is determined by a prediction variance criterion. A fitted regression model is used to make predictions throughout some region of interest. The prediction variance at any point is given by $d_i \hat{\sigma}^2$.

$$d_i = w_i(X'X)^{-1}w_i$$

where:

w_i = candidate design point
X = current design matrix
$\hat{\sigma}^2$ = estimate of experimental error

In the add procedure the candidate city with the maximum prediction variance is added to the experimental design. Repeated additions monotonically decrease the maximum prediction variance of the selected set in the candidate set. This in turn effectively decreases the variance of the estimated regression coefficients.

The exchange procedure begins by adding a city (as above) to the existing n point design. Then the design point (in the new n+1 point design) with the minimum prediction variance is removed from the design.

As the selection process takes place, the effectiveness of the successive designs is monitored by the criteria measures d and %G efficiency.

The maximum prediction variance $d\sigma^2$ is given by:

$$d = \max_{w_i \varepsilon W}\{w_i'(X'X)^{-1}w_i\}$$

where:

W = the set of all candidate points (cities)
w_i = a particular city
X = design matrix for current cities in the design

The other measure %G efficiency is defined as

$$\%G = \frac{100p}{nd}$$

where:

p = number of regression model parameters
n = number of design points (cities)
d = defined above

For an effective design $d \leq 1$ and $G \geq 50$ are desirable. Designs with small d enable good regression model predictions. Designs with %G efficiency from 50 to 75 are efficient and cost effective in the sense that the number of design points is kept to a minimum. That is, it is usually not cost effective to increase %G efficiency beyond 75 by adding additional points to the design.

B. Development of Climate Indicators

The climate indicators used in this analysis were chosen from the pool of climate variables driving the building hourly loads in the DOE-2.1 code so as to establish the highest degree of correspondence between dependent and independent variables. These climate variables are:

Building Latitude
Building Longitude
Building Altitude
Building Location--Time Zone

Hourly Ambient Dry Bulb Temperature
Hourly Ambient Wet Bulb Temperature
Hourly Atmospheric Pressure
Hourly Wind Speed
Hourly Wind Direction
Hourly Insolation

From these, four factors have been given consideration:

Dry Bulb Temperature
Humidity
Wind Speed
Insolation

The hourly variations in atmospheric pressure were not considered significant. However, the geographical variation of this variable is implicitly included in the hourly distributions of temperature and humidity as locations are systematically compared to one another.

The type of statistics chosen to represent these four factors were TRY measures accumulated hourly for heating and cooling. The reasons for this choice are as follows:

- Designed energy consumption values are generated from TRY data.
- The cumulative function is representative of the hourly distributions and is much less sensitive to atypical and extreme values. This is an important attribute since TRY data is not considered sufficiently typical to produce reliable estimates of average energy requirements over several years. Also, they are more accurate indicators of a distribution than the average or the mean which

often cancel the swings and flywheel effects about a central value.

Cooling and heating indicators were treated separately because not all climate variables affect the building types being analyzed for both heating and cooling. For instance, humidification is not a standard practice in mobile homes, single family dwellings or multifamily units. Also, the building's mode of operation changes from winter to summer.

The specific thermal characteristics of given building types are explicitly accounted for by using a balance point approach incorporating a dead band. Balance points for both dry bulb temperature and humidity are defined. The balance point allows for a proper calculation of the cumulative measures being proposed. The cumulative value for any given indicator for heating or cooling will be determined by the balance point corresponding to the thermal profile of the building being analyzed. (For example, the value of cooling insolation used in the case of shopping centers is the summation of the total hourly insolation on a horizontal surface for those hours where the dry temperature is superior to the balance point for that building type.)

The dead band reflects gaps between indoor heating and cooling points; their values will also vary according to the building type considered. The algorithms used to calculate these balance points are described below.

C. Algorithm Development

This section reviews the algorithms used to compute the data inputs for each climate variable.

1. Dry Bulb Temperature

   Indicators proposed for this analysis:

   - Heating degree hours
   - Cooling degree hours

   Heating and cooling degree hours are used here as dry bulb temperature indicators. The base selected depends on the average balance temperature of the building type considered. Computation of the balance temperatures considers the impact of the following factors: composite shell coefficient of transmission, mechanical ventilation, lighting, occupancy loads and direct solar radiation adjusted for cloud cover.

   The following expression was used.

(COMPOSITE "U" x EXPOSURE AREA/NET PERIMETER AREA) Td + (TOTAL O.A. CFM x 1.08/NET PERIMETER AREA) Td + 230/SQ FT PER PERSON + LIGHTS BTU/SQ FT/YR x % of PROFILE/# HOURS OF OPERATION PER YR + SOLAR HEAT GAIN FACTOR x %POSSIBLE SUNSHINE x AREA OF GLAZING PER SQ FT OF PERIMETER AREA x SHADING COEFFICIENT = 0

Where:

- Td is outdoor/indoor temperature difference
- % of Profile is the weighted percentage of operating hours falling under weekday operating conditions.

After numerical substitution this expression is reduced to a simple linear function with Td as the only unknown:

$$aTd + b = 0$$

The slope a, depends on the composite "u" value and the quantities of outdoor air (O.A CFM) brought in the building. O.A CFM are in turn dependent on:

- Minimum outside air requirements dictated by local codes.
- Infiltration levels, i.e., tightness of the shell (in the case of non-pressurized buildings only).
- Economy of system operation.
- Occupant ventilation levels (for residential only).

The constant term b is a function of the internal loads and seasonal solar loads.

Finally, the balance temperature is simply the difference between the heating or cooling indoor set points and the solved Td value from the equation above:

$$Tbal = \text{Indoor set point} - Td$$

2. Humidity

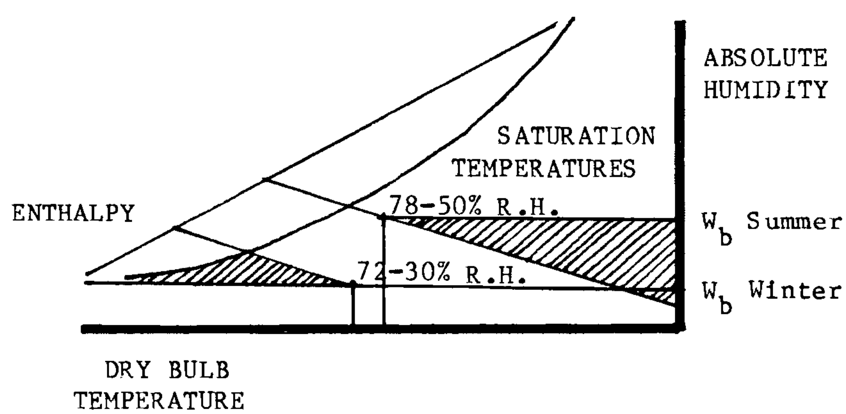
The humidity cumulative measures that were considered for this analysis appear below:

- Humidity ratio hours
- Dew point hours
- Wet bulb temperature
- Enthalpy hours

Enthalpy and wet bulb hours were discarded because there are a range of situations where differences between balance enthalpy/wet bulb and outdoor air conditions indicate that humidification or dehumidification energy is used when in fact no energy is required.

For heating, any point above the heating balance humidity ratio and below the balance wet bulb/enthalpy line will yield a higher relative humidity than required by indoor conditions after sensible heating. For cooling, any point below the cooling balance humidity ratio and above the balance wet bulb/enthalpy line will yield a lower relative humidity than required. The accumulation of such values could potentially introduce a bias in locations with relatively dry hot summers or humid winters.

Figure 5.1 below, illustrates these cases on the psychrometric chart.



Both the humidity ratio and dew point avoid this pitfall. Humidity ratio hours have been selected as the indicator over dew point for the simple reason that it is readily available in binary form from the DOE-2.1X weather file.

The potential impact of humidity is then represented as the summation of the differences between ambient humidity ratios and the balance humidity ratio. Balance humidity ratios are computed for heating and cooling indoor set points crediting occupancy latent contributions.

Latent Contribution from Occupants (Lo) is expressed as:

$$Lo = \frac{190\ (1 - \%\ O.A.)}{\text{occupancy density}\ (h_{fg})} \qquad \#\ \text{moisture sq ft hr}$$

Where:

- 190 is the latent heat contribution per occupant (BTU/hr person)
- % O.A. is percent of outside air
- occupancy density is expressed in sq. ft. per person
- h_{fg} is the latent heat of vaporization expressed in BTU per # moisture

Occupancy Latent Credit = Lo/(CFM.sqft x 60/V) # moisture per # of air

Where:

- CFM is cubic feet per minute
- V is the specific volume of air at a given temperature, at sea level expressed in cubic feet per pound of air.

3. Insolation

Indicators proposed for this analysis:

- Heating insolation hours
- Cooling insolation hours

These are calculated from hourly total incident radiation on a horizontal surface corrected for cloud cover. The calculation of cloudy day solar radiation was made using the Kimura and Stephenson routine.

This routine estimates the factor called CCF to modify the total solar radiation on a horizontal surface with the observed cloud cover data for a cloudy sky condition. The cloud cover observations are made every hour at major weather stations by experienced observers who estimate the amount of cloud on a scale of 0 to 10 and indicate the type of cloud in four different layers. Kimura and Stephenson analyzed 1967 Canadian data for observed solar radiation with respect to the cloud cover data, type of cloud, and the calculated solar radiation under cloudless condition at the same solar time. Based upon their analysis, a comprehensive methodology was developed for calculating the cloudy day solar radiation.

The bases and dead band for heating and cooling are determined by the balance temperatures which vary according to the building type considered.

4. Wind Speed

Indicators proposed for this analysis:

- Heating wind speed hours
- Cooling wind speed hours

These are calculated from hourly wind speeds, the bases and dead band for heating and cooling are determined by the balance temperatures which vary according to the building type considered. The significance of either one of these variables will be later determined by their explained variances as generated in regression analyses to follow.

VI. COMMERCIAL-MULTIFAMILY CLIMATE SELECTION

A. Objectives

This section discusses the proposed commercial-multifamily (CMF) climate selection. The objectives for the selection are listed below:

- Select a minimum number of climate locations for commercial and multifamily buildings allowing seasonally accurate prediction at all locations.

- The selection procedure should include the effects of high internal loads which characterize commercial structures.

To fulfill the objectives of this climate analysis, a set of regression "experimental designs" were constructed using climate indicators derived from balance points. For commercial and multifamily buildings the heating "balance point" is that temperature below which energy from the heating system is required to maintain the inside temperature to make up for transmission and infiltration/ventilation losses. In general, the heating balance point gets lower as the following factors occur:

1. The shell gets "tighter", i.e. more insulation, less infiltration or ventilation.

2. Internal loads increase, i.e. more heat is generated inside the building from people, appliances and lights.

Cooling balance points are usually higher than heating balance points, since summer indoor set points and ventilation levels are higher than in winter.

These balance points enable the accurate accumulation of the climate indicators input to the construction of the experimental design. These accumulations about the balance points are defined for both dry bulb temperature and humidity. The cumulative values of any given indicator are determined separately for heating and cooling by the balance point responding to the thermal profile of the building being analyzed. Also, dead bands are included to reflect gaps between indoor heating and cooling set points.

The factors that have been selected from the pool of variables determining the building hourly loads were dry bulb temperature, humidity, wind speed and insolation. All climate indicators describing these factors are cumulative statistics derived from hourly data from Test Reference Years (TRY) for each location, the same data that is used in estimating the building loads for the subsequent energy analyses. (For details see previous section on the development of climate indicators.)

The experimental design as such is constructed from a starting design consisting of either randomly selected candidate climate locations or user chosen candidate climate locations. Locations are added or exchanged utilizing "add" and "exchange" algorithms which are part of a user interactive routine called ADDEXC.

The following paragraphs explain the process by which the CMF final design was completed. These include a discussion on the range of sensitivities mapped, along with the intermediate results obtained.

B. Method

This section describes the range of testing performed on those factors having a potential impact on the experimental design outputs. Previous results for residential and mobile homes indicated that the final climate locations were not sensitive to the choice of starting design and/or temperature/humidity balance points. Hence, a random starting design and average balance points were used for the CMF location selection process. The regression models are shown below:

TABLE 6.1

REGRESSION MODELS FOR COMMERCIAL-MULTIFAMILY BUILDINGS

- Linear Heating Variables
- Linear Cooling Variables
- Linear 4 Heating and Cooling Variables
- Linear 8 Heating and Cooling Variables
- Linear with Interactions

Below is a more detailed description of these models. Actual results are presented in the following two sections.

1. Regression Models

The ADDEXC routine deals with experimental designs tailored to the regression model chosen by the user. The following two general models were developed and tested.

1. Linear Heating Variables:

$$E_1 = a_1 + a_2 HDH + a_3 HWH + a_4 HIH + a_5 HWSH$$

2. Linear Cooling Variables:

$$E_2 = a_1 + a_2CDH + a_3CWH + a_4CIH + a_5CWSH$$

3. Linear Four Heating and Cooling Variables:

$$E_3 = a_1 + a_2HDH + a_3HWH + a_4CDH + a_5CWH$$

4. Linear Eight Heating and Cooling Variables

$$E_4 = a_1 + a_2HDH + a_3HWH + a_4HIH + a_5HWSH + a_6CDH + a_7CWH + a_8CIH + a_9CWSH$$

5. Linear with Interactions:

$$E_5 = a_1 + a_2HDH + a_3CDH + a_4HWH + a_5CWH + a_6HIH + a_7CIH + a_8HWSH + a_9CWSH + a_{10}HDH(CDH) + a_{11}HDH(HWH) + a_{12}CDH(CWH) + a_{13}HDH(HIH) + a_{14}CDH(CIH)$$

where:

HDH: Heating degree hours
CDH: Cooling degree hours
HWH: Heating humidity ratio hours
CWH: Cooling humidity ratio hours
HIH: Heating insolation hours
CIH: Cooling insolation hours
HWSH: Heating wind speed hours
CWSH: Cooling wind speed hours

These models were specified to cover as wide range of possible models and submodels between CMF designed energy consumption and climate indicators. In fact, they encompass the regression curves developed to derive the Budget Percentiles for Baseline and Redesigned Commercial Buildings. For all the building types defined in that analysis, the general form of the regressions was:

$$\text{Heating BTU} = a_H + b_H * \text{Heating Degree Days (Base 60)}$$

$$\text{Cooling BTU} = a_C + b_C * \text{Cooling Degree Days (Base 50)}$$

In the analysis leading to the specification of these regressions it was found that heating BTUs and cooling BTUs were required as cross product terms to adequately model energy use in buildings. These findings were incorporated in the specification of the interactive model used for this analysis. (For additional details on these regressions see Reference 4.)

2. Computation of Commercial Multifamily Climate Indicators

These sensitivites are designed to determine the extent to which the selection of climate locations is dependent on the building type. Temperature and humidity balance points were generated for the various internal load and insulation levels found in each type to be simulated taking into account differences between the winter and summer indoor set points and solar loads.

Phase II original data was used to compute these balance points. The building types considered were:

- Large offices
- Shopping centers
- Stores
- Warehouses
- Multifamily highrise

Tables 6.2 through 6.5 show data inputs used to derive temperature balance points. The following assumptions were made:

TABLE 6.2

AVERAGE PERIMETER AND EXPOSURE AREAS: DATA INPUTS

	NET FLOOR AREA*	STORIES ABOVE GRADE*	PERIMETER AREA	EXPOSURE AREA	ASPECT RATIO
LARGE OFFICE	167,828	8	67,604	75,020*	2
SHOPPING CENTERS	155,800	1	31,408	57,054	5
STORES	104,800	1	25,798	128,045	5
MULTI FAMILY HIRISE	103,108	3	103,018	64,151	5

* Phase II Original Data

TABLE 6.3

BALANCE TEMPERATURE DATA INPUTS (PHASE II ORIGINAL DATA)

TYPE	COMPOSITE "U" FACTOR	OUTSIDE AIR	LIGHTING BTU/SQ FT PER YEAR	LIGHTING HRS OF OPERATION & % PROFILE
LARGE OFFICE	.2606	200,364 TOT[1]		2600
		20,530 MIN	10,777	75%
		32,588 AV	23,372	
		41,060 MAX	38,139	
SHOPPING CENTERS	.1899	173,435 TOT[1]		3120
		10,845 MIN	8,996	82%
		18,075 AV	30,548	
		32,535 MAX	50,005	
STORES	.1228	114,206 TOT[1]		3120
		11,394 MIN	17,307	82%
		18,853 AV	29,955	
		52,411 MAX	40,100	
WAREHOUSES	.3646	25,336 TOT[1]		2600
		3,409 AV	9,060	96%
MULTIFAMILY HIRISE	.2480	66,293 TOT[1]	12,164	8760
		9,268 AV		100%

[1] Total CFM

TABLE 6.4

BALANCE TEMPERATURE DATA INPUTS (PHASE II ORIGINAL DATA)

TYPE	DENSITY SQ FT/ PERSON	SHADING COEFFICIENT	GLASS AREA /SQ FT OF PERIMETER AREA	SOLAR LOAD BTUH/SQ. FT.
LARGE OFFICE	100 MIN 126 AV 200 MAX	.49	.127	[2]W 4.60 [2]S 6.16
SHOPPING CENTERS	30 MIN 54 AV 90 MAX	.82	.085	W 2.06 S 2.76
STORES	50 MIN 139 AV 230 MAX	.78	.040	W .92 S 1.23
WARE-HOUSES	200[1] AV	.78	.032	W .74 S .99
MULTI-FAMILY HIRISE	142[1] AV	.69	.127	W 2.59 S 3.47

[1]Source: ASHRAE Fundamentals, p. 6, 21.14, Table 6

[2]W:Winter; S:Summer

TABLE 6.5

AVERAGE BALANCE TEMPERATURES

(Phase II Original Data)

	Balance Temperatures		
	WINTER[1]	SUMMER[2]	SUMMER 100% O.A.[3]
Large Offices	42* 45 49**	44* 48 52**	68
Shopping Centers	39* 43 48**	44* 48 53**	69
Stores	43* 48 60**	49* 54 65**	71
Warehouses	65	70	74
Multifamily Highrise	51	54	71

[1] Winter indoor set point 72°F

[2] Summer indoor set point 78°F

[3] Economizer cycle

* Minimum

** Maximum

- In the case of large offices, shopping centers, and stores, only the perimeter volume was considered, a depth of fifteen feet was assumed.

- The balance temperatures correspond to an average weekday operating condition.

- The assumed sensible heat from occupants is 230 BTUH.

- Maximum and minimum CFM correspond to changes in occupancy levels.

- Solar heat gain factors for 40 degrees north latitude, averaged for 16 compass orientations were used to calculate winter and summer solar heat gains. Also, the values used for percent of possible sunshine were: winter-48% and summer-68%.

- In one story situations glazing is assumed to be distributed uniformly between the perimeter and core areas due to the possible use of skylights.

Table 6.5 is a summary of average balance temperatures; minimum and maximum values are based on min-max ranges for lighting and outside air adjusted for occupancy ranges. Summer 100% outside air balance temperature corresponds to the operation of an economizer cycle.

Tables 6.6 and 6.7 show balance humidity ratios computed from Phase II Original Data.

From these tables it appears that variations from type to type on latent occupancy contributions are not a significant factor in the climate selection. Large

TABLE 6.6

BALANCE HUMIDITY RATIO DATA INPUTS

TYPE	AREA	TOTAL CFM	Ma/HR SQ FT	% O.A.	OCCUPANT DENSITY SQ FT/PERSON
LARGE OFFICES	167,828	200,364	5.31	16	126
SHOPPING CENTERS	155,800	173,435	4.95	10	54
STORES	104,800	114,206	4.84	17	139
WAREHOUSES	35,521	25,336	3.17	13	200
MULTIFAMILY HIRISE	103,018	66,293	2.86	14	142

OTHER DATA:

Latent Heat Contribution: 190 BTU/HR PERSON

h_{fg} (72) = 1052 BTU

h_{fg} (78) = 1049 BTU

V (72-30RH) = 13.5 CUFT/#

V (78-50) = 13.8 CUFT/#

Latent Contribution From Occupants:

$$Lo = \frac{190(1-\%\ O.A.)}{occ.\ density\ (h_{fg})}\ \#\ moisture/sq\ ft/hr$$

occ. latent credit = Lo/CFM.sqft x 60/V # moisture per # dry air

TABLE 6.7

HUMIDITY RATIO BALANCE POINTS
(Phase II Original Data)

TYPE	OCCUPANCY[1] LATENT CREDIT (10^{-5})	BALANCE[2] HUMIDITY RATIOS WINTER[1]	SUMMER[1]
LARGE OFFICES	23	.00468	.01007
SHOPPING CENTERS	62	.00429	.00968
STORES	23	.00468	.01007
WAREHOUSES	25	.00465	.01005
MULTIFAMILY HIRISE	39	.00452	.00991

[1] # Moisture per # of Dry Air

[2] Winter Indoor Set Point: 72°F - 30 RH

Summer Indoor Set Point: 78°F - 50 RH

Offices, Stores, and Warehouses show an insignificant spread in their winter and summer balance humidity ratios (maximum spread - 4% for winter and 1% for summer). Shopping centers are probably the only type showing a relatively significant spread (9% for winter, 3.5% for summer).

These balance points set the range of sensitivities testing the impact of building type variation on the climate selection.

TABLE 6.8

CMF AVERAGE BALANCE TEMPERATURE RANGES

	WINTER	SUMMER	
		MIN O.A.	100% O.A.
Mimimum	43	48	69
Maximum	65	70	74

The average balance temperature used in the regression experimental design location selection was 45°F for heating and 57°F for cooling. The heating balance point is the average modal winter balance temperature for all building types. A dead band of 12°F is the non-weighted average of the average between economizer and non-economizer dead bands for all building types.

The balance humidity was set at .00468 and .01007 # of moisture/# dry air for winter and summer respectively. These levels are representative of modal values. Accordingly, the resulting data inputs to the experimental design are as follows (See Appendix A):

- Heating Degree Hours (HDH) at base 45°F.

- Cooling Degree Hours (CDH) at base 57^{o}F.
- Heating Humidity Ratio Hours (HWH) at .00468 pounds of moisture/pounds of dry air.
- Cooling Humidity Ratio Hours (CW) at .1007 pounds of moisture/pound of dry air.
- Heating Insolation Hours (HIS) for the hours below 45^{o}F.
- Cooling Insolation Hours (CIS) for the hours above 57^{o}F.
- Heating Wind Speed Hours (HWSH) for the hours below 45^{o}F.
- Cooling Wind Speed Hours (CWSH) for the hours above 57^{o}F.

The following two sections provide results for the range of sensitivities just described.

C. Intermediate Results

This section discusses the process that led to the CMF climate selection.

Once a starting design is chosen, the CMF Climate Selection process proceeds by either adding or exchanging locations. The choice of a candidate point to add or exchange is determined by a prediction variance criterion. (See Section V (A) for a general description.)

The regression experimental design city selection is shown for models 1 to 5 in Tables 6.9 to 6.13, respectively. The procedure used a random start for models 1, 2, and 3. The cities selected by model 1 were used as a starting design for models 4 and 5. The design name in each case describes the number of cities in the design and the properties of the

TABLE 6.9

CMF CITY SELECTION USING MODEL 1 AND AVERAGE BALANCE POINTS

DESIGN NAME	BEST 5	BEST(5)6	BEST 6	BEST(6)7	BEST 7	BEST(7)8	BEST 8	BEST(8)9	BEST 9	BEST(9)10	BEST 10
G	72.1	82.1	82.1	85.0	85.0	88.8	88.8	83.1	94.5	103.1	104.1
D	1.4	1.0	1.0	0.8	0.8	0.7	0.7	0.7	0.6	0.5	0.5
CITIES											
Cheyenne								X	X	X	X
Albuquerque	X	X	X	X	X	X	X	X	X	X	X
Bismarck	X	X	X	X	X	X	X	X	X	X	X
El Paso	X	X	X	X	X	X	X	X	X	X	X
Fresno	X	X	X	X	X	X	X	X			
Great Falls	X	X	X	X	X	X	X	X	X	X	X
Portland, ME		X	X	X	X	X	X	X	X	X	X
Seattle				X	X	X	X	X	X	X	X
San Diego						X	X	X	X	X	X
Salt Lake									X	X	
Los Angeles										X	X
Medford											X

TABLE 6.10

CMF CITY SELECTION USING MODEL 2 AND AVERAGE BALANCE POINTS

DESIGN NAME	BEST 5	BEST(5)6	BEST 6	BEST(6)7	BEST 7	BEST(7)8	BEST 8	BEST(8)9	BEST 9	BEST(9)10	BEST 10
G	60.1	66.7	66.7	67.8	79.8	77.3	77.3	98.7	98.7	103.6	103.6
D	1.7	1.2	1.2	1.1	0.9	0.8	0.8	0.6	0.6	0.5	0.5
CITIES											
Buffalo	X	X	X	X							
San Francisco	X	X	X	X	X	X	X	X	X	X	X
Miami	X	X	X	X	X	X	X	X	X	X	X
Lubbock	X	X	X	X							
Phoenix	X	X	X	X	X	X	X	X	X	X	X
Brownsville		X	X	X	X	X	X	X	X	X	X
Seattle				X	X	X	X	X	X	X	X
Los Angeles					X	X	X	X	X	X	X
Oklahoma					X	X	X	X	X	X	X
El Paso						X	X	X	X	X	X
Burlington								X	X	X	X
Lake Charles										X	X

TABLE 6.11

CMF CITY SELECTION USING MODEL 3 AND AVERAGE BALANCE POINTS

DESIGN NAME	BEST 5	BEST(5)6	BEST 6	BEST(6)7	BEST 7	BEST(7)8	BEST 8	BEST(8)9	BEST 9	BEST(9)10	BEST 10
C	97.6	95.2	95.2	95.6	95.6	93.3	93.3	103.8	103.8	102.5	102.5
D	1.0	0.9	0.9	0.7	0.7	0.7	0.7	0.5	0.5	0.5	0.5
CITIES											
Cheyenne	X	X	X	X	X	X	X	X	X	X	X
Miami	X	X	X	X	X	X	X	X	X	X	X
Bismarck	X	X	X	X	X	X	X	X	X	X	X
San Francisco	X	X	X	X	X	X	X	X	X	X	X
Phoenix	X	X	X	X	X	X	X	X	X	X	X
Philadelphia		X	X	X	X	X	X	X	X	X	X
Brownsville				X	X	X	X	X	X	X	X
Seattle						X	X	X	X	X	X
El Paso								X	X	X	X
Minneapolis										X	X

TABLE 6.12

CMF CITY SELECTION USING MODEL 4 AND AVERAGE BALANCE POINTS

DESIGN NAME	START 10 FROM MODEL 1	BEST 10(5F)	BEST(10(5F))15	BEST 15(10F)	START 10 FROM MODEL 1	BEST 10	BEST(10)15	BEST 15
G	33.0	43.8	93.7	93.7	33.0	33.0	74.8	93.7
D	2.7	2.1	0.6	0.6	2.7	2.7	0.8	0.6
CITIES								
Cheyenne	X	X	X	X	X	X	X	X
Miami	X	X	X	X	X	X	X	X
Bismarck	X	X	X	X	X	X	X	X
San Francisco	X	X	X	X	X	X	X	X
Phoenix	X	X	X	X	X	X	X	X
Albuquerque	X	X	X	X	X	X	X	X
El Paso	X	X	X	X	X	X	X	X
Great Falls	X		X	X	X	X	X	X
Buffalo	X				X	X	X	
Lubbock	X				X	X	X	
Portland, ME		X	X	X			X	X
Seattle		X	X	X			X	X
Oklahoma		X	X	X				X
Brownsville			X	X			X	X
Burlington			X	X			X	X
Los Angeles			X	X			X	X
Salt Lake			X	X				X

TABLE 6.13

CMF CITY SELECTION USING MODEL 5 AND AVERAGE BALANCE POINTS

DESIGN NAME	START BEST 15(10F)	BEST 15(5F)	BEST 15(10F)	BEST(15)20	BEST 20(15F)	START BEST 15(4b)	BEST 15	BEST(15)20	BEST 20
G	5.7	29.5	29.5	57.2	58.1	5.7	30.7	61.5	61.5
D	16.4	3.2	3.2	1.2	1.2	16.4	3.0	1.1	1.1
CITIES									
Cheyenne	X	X	X	X	X	X	X	X	X
Miami	X	X	X	X	X	X	X	X	X
Bismarck	X	X	X	X	X	X	X	X	X
San Francisco	X	X	X	X	X	X	X	X	X
Phoenix	X	X	X	X	X	X	X	X	X
Albuquerque	X	X	X	X	X	X	X	X	X
El Paso	X	X	X	X	X	X	X	X	X
Great Falls	X	X	X	X	X	X	X	X	X
Portland, ME	X			X	X	X		X	X
Seattle	X	X	X	X	X	X	X	X	X
Oklahoma	X			X		X	X	X	X
Brownsville	X	X	X	X	X	X		X	X
Burlington	X	X	X	X	X	X	X	X	X
Los Angeles	X					X	X	X	X
Salt Lake	X	X	X	X	X	X	X	X	X
Lubbock		X	X	X	X		X	X	X
Minneapolis		X	X	X	X			X	X
Lake Charles		X	X	X	X		X	X	X
Richmond				X	X				
San Diego				X	X				
Madison				X	X			X	X
Fort Worth					X				
Omaha							X	X	X

design. For example, Best(7)8 is interpreted as the best seven cities. Best 8 differs by being the best eight cities for the model. Best 15 (10F) means the optimum 15 cities are selected but that 10 of the starting design cities are fixed (F) in the design.

An examination of the design properties for the different models illustrates the stability of the prediction variance for even a limited number of cities. Across models the same cities tend to reoccur, especially when 10 or more cities are in the design.

D. Final Results

The CMF final selection is made of those locations that were most recurrent across balance temperatures. These are listed in Table 6.14.

The experimental design building process has selected points representing extreme climate conditions. This is mainly because the larger the spread of the independent variable observations, the smaller the variance of the regression coefficient.

No intermediate climates are required if the basic premise that relationships of the type described in the specified models used in this design accurately depict the relationship between energy consumption and the climate indicators developed for the analyses. Bearing in mind this caveat, this experimental design selection process yields low prediction variance for the regression coefficients.

This hypothesis could be checked by 1) predicting the energy performance of one or more intermediate

TABLE 6.14

CMF FINAL CITY SELECTION

5 City Sets				15 and 20
Heating	Cooling	Combined	10 City Set	City Set
Fresno				
Albuquerque			Albuquerque	Albuquerque
Bismarck		Bismarck	Bismarck	Bismarck
El Paso			El Paso	El Paso
Great Falls			Great Falls	Great Falls
	San Francisco	San Francisco	San Francisco	San Francisco*
	Miami	Miami	Miami	Miami
	Phoenix	Phoenix	Phoenix	Phoenix
	Buffalo		Buffalo	
	Lubbock		Lubbock	Lubbock
		Cheyenne	Cheyenne	Cheyenne
				Seattle
				Los Angeles
				Oklahoma City
				Burlington
				Lake Charles
				Salt Lake City
				Omaha
				Portland, ME*
				Brownsville*
				Minneapolis*
				Madison*

*Included in 20 city set.

climate locations by using the regression model(s) from the climate selection procedure, and 2) comparing the results of step 1 with the results obtained by conducting energy simulations at the same locations using the full hour by hour TRY data.

To summarize, the attributes of the Final CMF Selection are as follows:

- Reasonable statistical prediction for all locations.
- Coverage of the entire range of climate variation: This requires selected points at the extremes.
- Does not yield a sample which is stratified according to climate zones.
- Absence of redundancy among locations.
- Coverage for the entire range of variation of balance temperature and humidity points found in Commercial Multifamily Buildings.

VII. RESIDENTIAL CLIMATE SELECTION

A. Objectives

This section discusses the Single Family Residential Climate Selection procedures and results. The specific objectives for this selection are listed below:

- Find the fewest possible number of climate sites which guarantee reasonable prediction for the residential budget selections at all locations.
- Select locations that are spread throughout the 50 states so that the various possible combinations among climate variable ranges are best represented.
- Specifically incorporate in the selection procedure data on the envelope and operational characteristics of residential prototypes.

The output of this effort is a ranked subset of energy simulation sites for residential housing having a proven predictive value.

Also, see Section III for a discussion of the general objectives of this climate analysis.

B. Method

Refer to Section V above for a full discussion of the climate location selection methodology. This section discusses key features of the methodology as applied specifically to the analysis of potential climate locations for Single Family Residences (SFR). Thus, this section follows the general outline of Section V and describes the range of testing performed on those factors having a potential impact on the SFR experimental design outputs. The mapped sensitivities are shown below:

Table 7.1

SENSITIVITY PLAN FOR THE SINGLE FAMILY RESIDENTIAL SELECTION

FACTOR	VARIATION
Regression Model:	Linear with no interactions
	Linear with interactions
	Quadratic
	Quadratic excluding wind speed
Temperature Balance Points:	Minimum Range
	Average Range
	Maximum Range

These sensitivities are designed to test the full range of variation in the selection. Below is a more detailed description of these items, actual results are presented in the following two sections.

1. Residential Regression Models

The ADDEXC routine deals with experimental designs tailored to the regression model chosen by the user. The following four models were tested in the case of the SFR Selection.

1. Energy consumption assumed as a linear function of the following eight independent variables:

$E_1 = a_1 + a_2 HDH + a_3 CDH + a_4 HWH + a_5 CWH + a_6 HIH +$

$a_7 CIH + a_8 HWSH + a_9 CWSH$

where:

HDH: Heating degree hours
CDH: Cooling degree hours
HWH: Heating humidity ratio hours
CWH: Cooling humidity ratio hours
HIH: Heating insolation hours
CIH: Cooling insolation hours
HNSH: Heating wind speed hours
CWSH: Cooling wind speed hours

2. Same as one above, but in addition five cross products are included:

- Heating and cooling degree hours
- Heating degree hours and heating humidity hours
- Cooling degree hours and cooling humidity ratio hours
- Heating degree hours and heating insolation hours
- Cooling degree hours and cooling insolation hours

$$E_2 = a_1 + a_2 HDH + a_3 CDH + a_4 HWH + a_5 CWH$$
$$+ a_6 HIH + a_7 CIH + a_8 HWSH + a_9 CWSH$$
$$+ a_{10} HDH(CDH) + a_{11} HDH(HWH)$$
$$+ a_{12} CDH(CWH) + a_{13} HDH(HIH) + a_{14} CDH(CIH)$$

3. Same as one above, but in addition four quadratic

terms are included for:

- Heating humidity ratio hours
- Cooling humidity ratio hours
- Heating insolation hours
- Cooling insolation hours

$$E_3 = a_1 + a_2 HDH + a_3 CDH + a_4 HWH + a_5 CWH + a_6 HIH + a_7 CIH + a_8 HWSH + a_9 CWSH + a_{10} HWH^2 + a_{11} CWH^2 + a_{12} HIH^2 + a_{13} CIH^2$$

4. Same as three above, except that the wind speed factors for heating and cooling are excluded and one additional quadratic term is included for heating degree hours.

$$E_4 = a_1 + a_2 HDH + a_3 CDH + a_4 HWH + a_5 CNH + a_6 HIH + a_7 CIH + a_8 HWH^2 + a_9 CWH^2 + a_{10} HIH^2 + a_{11} CIH^2 + a_{12} HDH^2$$

These models were specified to cover a wide range of likely models and submodels between SFR designed energy consumption and climate indicators. In fact, they encompass the regression curves developed by Lawrence Berkeley Laboratory (LBL) for the single-family detached (SFD) and attached (SFA). LBL calculated the energy budgets for electric and gas heated SFD and SFA homes using these equations.

For electrically heated SFD homes, the total (combined heating and cooling) energy budget was regressed against heating degree-days (HDD) at a base of 60°F and cooling degree days (CDD) at a base of 50°F. The form of the regression was:

$$E_B = a_1 + a_2HDD + a_3HDD^2 + a_4CDD$$

where:

E_B = energy budget (at the building boundary), and a_1, a_2, a_3, and a_4 coefficients determined from the regression analysis.

For gas heated/electric air-conditioned homes, the heating and cooling components of the energy budgets were split and a regression analysis performed on each. This is because the heating fuel is different from the cooling. The heating budgets are regressed with HDD while the cooling budgets are done with CDD. The regression equations were in the form:

$$E_h = a_1 + a_2HDD^2 + a_3HDD$$

$$E_c = a_4 + a_5CDD$$

where:

E_h = gas heating energy budget

a_1, a_2, a_3 = regression coefficients in heating budget equation

E_c = cooling energy budget, and

a_4, a_5 = regression coefficients in the cooling budget equation

The fit of the LBL model to the data was extremely good. The coefficient of determination (r^2) shows how well a regression fits the data., It can vary from 0 to 1.0. If r^2 is zero, then there is no correlation. If it is 1.0, then there is perfect correlation. The r^2 for the electrically heated/air conditioned SFD and SFA homes is 0.973 and 0.988, respectively. For the SFD homes, the coefficient of determination for the heating and cooling budget regressions are 0.991 and 0.931. (For additional details see TSD #3 Energy Budget Levels Section, App. J).

A priori, linear models should provide adequate representation of the likely impact of climate factors on the energy consumption of residences for the following reasons.

- The systems involved in this type of application are single zone with no reheat, and for the most part coil and space loads can be assumed directly proportional.

- Temperature: Under steady-state conditions, conduction losses and gains are directly proportional to the indoor-outdoor temperature differences.

- Humidity: Latent loads (Q_L) and changes in humidity ratio's (dW) are directly proportional. This is ordinarily expressed as:

  Q_L=4840 (CFM) dW
  Where:
  CFM: Airflow in cubic feet per minute
  dW: In-outdoor humidity ratio difference

- Wind speed: Infiltration is driven by pressure differences caused by wind speed and the temperature differences between inside and outside. Empirical results of infiltration have been statistically fit to simple equations which are typically linear in both wind speed and temperature differences. The Coblenz-Achenback equation, a simple multiple regression equation, has produced observed results in several important cases and is as accurate and realistic as anything available today.

  The form of this equation is:

  $$AC = 0.252 + 0.0218\ WS + 0.0084\ (T_A - T_R)$$

  where:

  AC = the air exchange rate in air changes per hour
  WS = the wind speed in miles per hour
  T_A = the ambient air temperature (^oF)
  T_R = the room temperature (^oF).

- Insolation: Direct solar gain (DSG) through non-opaque surfaces is directly proportional to the solar heat gain factor (SHGF): this is ordinarily expressed as:

  $$DSG=C(SHGF)$$

  where C is a constant determined by the shading coefficient and percent of possible sunshine.

  The solar impact on opaque surfaces could potentially introduce a time lag as an additonal factor. However, this time lag should not cause a significant bias in standard residential construction Ifor the following reasons:

- The insolation indicators used in this analysis are cumulative.
- Heat build up is most important in roofs and standard construction practice utilizes continuous soffit vents to dispose of the hot air accumulated in attic spaces.

2. Computation of Residential Climate Indicators:

The SFR sensitivities are designed to determine the extent to which the selection is dependent on the prototype configuration.

Temperature balance points were generated for the minimum and maximum levels of insulation found in single story detached houses and townhouses, taking into account differences between the winter and summer indoor set points and solar loads (for a detailed explanation of how these balance points are calculated, see Section 5).

Two prototype houses were used for the analysis: the single story detached and the two-story townhouse developed in the Hastings Report from the National Bureau of Standards (Hastings, 1977).

SFR Balance Points, data inputs and residential temperature balance points are shown in Tables 7.2 and 7.3. Summer balance temperatures were calculated at low and high infiltration levels, i.e., .6 and 10 air changes per hour, to check the effect of window opening on the balance temperatures. As ventilation levels increase, the balance temperature approaches the indoor set point.

Table 7.2

SINGLE FAMILY RESIDENTIAL BALANCE TEMPERATURE DATA INPUTS*

	SINGLE STORY DETACHED	TOWNHOUSE
Exposed Shell Area	2296	1358
Floor Area	1176	1315
Volume (Cu.Ft.)	9408	10520
Glass Area (% of Floor Area)	15	15
Frame Area (% of Wall Area)	10	10

Other Data:

Infiltration:* .6 air changes/hr

Internal Loads:* 53101 BTU.Day

Occupancy: 3.2 persons/household

Solar Loads:

Winter: 12.3 BTU/hr. sq.ft. glass

Summer: 26.4 BTU/hr. sq.ft. glass

Indoor Set Points:*

Winter: 70°F - 30% RH

Summer: 78°F - 50% RH

INSULATION*

	Minimum	Maximum
Ceiling	19	38
Wall	11	27
# Panes	1	3

*Source: U.S. Department of Energy; "Energy Budget Levels Selection, TSD #3, November, 1979.

Table 7.3

SINGLE FAMILY RESIDENTIAL TEMPERATURE BALANCE POINTS

		.6 Air Changes	10 Air Changes	Average
Single Story Detached:				
Composite	Winter	60		
"U" = .15	Summer	63	Summer 75	69
Composite	Winter	51		
"U" = .06	Summer	49	Summer 74	61.5
Townhouse:				
Composite	Winter	58		
"U" = .19	Summer	58	Summer 75	66.5
Composite	Winter	50		
"U" = .088	Summer	46	Summer 74	60

Sensitivity Range: Winter/Summer ^{o}F.

Minimum 50-60

Average 55-65

Maximum 60-70

In the case of humidity, it was assumed that high ventilation levels during the summer dissipate occupant latent contributions. Winter occupancy latent credits were calculated at 22x 10^{-5} # of moisture per # of dry air; 3 air changes of total ventilation and infiltration were assumed.

TABLE 7.4

Single Family Residential Humidity Balance Points

	Indoor Set Point	Humidity Ratio	Balance Humidity Ratio
Winter	70-30% RH	.00468	.00446
Summer	78-50% RH	.01027	.01027

These balance points determine the range of sensitivities testing the impact of prototype configuration. The resulting data inputs to the SFR climate selection process are as follows (See Appendix A):

- Heating Degree Hours (HDH): bases 50, 55 and 60°F.
- Cooling Degree Hours (CDH): bases 60, 65 and 70°F.
- Heating Humidity Ratio Hours (HWH): bases .00446 pounds of moisture per pound of dry air.
- Cooling Humidity Ratio Hours (CWH): base .01027 pounds of moisture per pound of dry air.
- Heating Insolation Hours (HIS) for the hours below 50, 55 and 60°F.
- Cooling Insolation Hours (CIS) for the hours above 60, 65 and 70°F.
- Heating Wind Speed Hours (HWSH) for the hours below 50, 55 and 60°F.
- Cooling Wind Speed Hours (CWSH) for the hours above 60, 65 and 70°F.

The following two sections provide results for the range of sensitivities just described.

C. Intermediate Results

This section discusses the residential climate sensitivity results.

Once a starting design is chosen, the Residential Climate Selection building process proceeds by either adding or exchanging locations. The choice of a candidate point to add or exchange is determined by a prediction variance criterion. (For a more detailed account of the procedure, refer to Section V (A).)

Tables 7.5 and 7.8, below, show the outcome of this selection process for all sensitivities. The following observations can be made:

- Variations in prototype configuration do not have a significant impact on the climate selection. If we compare across balance point ranges, the number and the spread of the changes that occurred were very limited.
- The statistical properties of the Residential Climate Selection remained virtually unchanged across balance points and models tested.
- The Residential Climate Selection will perform equally well or better for any submodel derived from any of the four models tested.

TABLE 7.5

RESIDENTIAL CITY SELECTION FOR MODEL 1 (EIGHT VARIABLE/LINEAR) USING MINIMUM BALANCE POINTS

DESIGN NAME	START 9	BEST 9		START(9)12	BEST(9)12		BEST 12		START(12)15		BEST 15	
START DESIGN	-	START 9		START 9	BEST 9		BEST(9)12		START(9)12		START(12)15	
ADD/EXCHANGE	-	EXCHANGE		ADD 3	ADD 3		EXCHANGE		ADD 3		EXCHANGE	
FIXED/RANDOM	F	F	R	F	F	R	F	R	F	R	F	R
G	0.5	27.1	33.7	25.9	44.8	72.3	75.1	75.1	44.2	74.2	76.8	89.2
D	221.5	3.7	3.0	2.9	1.7	1.0	1.0	1.0	1.4	0.8	0.8	0.7
CITIES												
Miami	X	X		X	X	X	X	X	X	X	X	X
Bismarck	X	X	X	X	X	X	X	X	X	X	X	X
Phoenix	X	X	X	X	X	X	X	X	X	X	X	X
Great Falls		X	X	X	X	X	X	X	X	X	X	X
Seattle					X	X	X	X	X	X	X	X
Brownsville			X			X	X	X	X	X	X	X
El Paso			X		X	X	X	X		X	X	X
San Diego										X		X
Lake Charles	X			X					X		X	
San Francisco												
Fresno												
Burlington							X	X	X	X	X	X
Oklahoma City											X	X
Cheyenne												
Salt Lake City												
Albuquerque			X		X	X	X	X	X	X	X	X
Medford	X	X		X	X				X		X	X
Lubbock		X		X	X	X	X	X	X	X	X	X
Los Angeles		X	X	X	X	X	X	X	X	X	X	X
Richmond										X		X
Jacksonville												
Washington, DC												
Raleigh	X			X					X			
Fort Worth	X	X		X	X				X			
Kansas City	X			X						X		
Portland, ME	X	X	X	X	X	X	X	X	X	X	X	
Portland, OR			X			X				X		

TABLE 7.6

RESIDENTIAL CITY SELECTION FOR MODEL 1 (EIGHT VARIABLE/LINEAR) USING AVERAGE BALANCE POINTS

DESIGN NAME	START 9	BEST 9		START(9)12	BEST(9)12		BEST 12		START(12)15		BEST 15	
START DESIGN	-	START 9		START 9	BEST 9		BEST(9)12		START(9)12		START(12)15	
ADD/EXCHANGE	-	EXCHANGE		ADD 3	ADD 3		EXCHANGE		ADD 3		EXCHANGE	
FIXED/RANDOM	F	F	R	F	F	R	F	R	F	R	F	R
C	1.3	38.3	1.0	22.7	77.0	8.3	77.0	76.3	55.0	27.0	82.8	78.0
D	78.1	2.6	104.9	3.3	1.0	9.1	1.0	1.0	1.1	2.2	0.7	0.8
CITIES												
Miami	X		X	X		X		X	X	X	X	X
Bismarck	X	X		X	X	X	X	X	X	X	X	X
Phoenix	X	X		X	X		X	X	X	X	X	X
Great Falls		X		X	X	X	X	X	X	X	X	X
Seattle		X			X		X	X	X	X	X	X
Brownsville		X			X		X	X	X		X	X
El Paso					X	X	X	X		X	X	X
San Diego		X	X	X	X	X	X	X	X	X	X	X
Lake Charles	X	X		X	X		X		X		X	
San Francisco												
Fresno					X		X				X	
Burlington												
Oklahoma City											X	
Cheyenne												
Salt Lake City												
Albuquerque					X		X	X	X	X	X	X
Medford	X			X					X			
Lubbock		X		X	X		X	X	X		X	X
Los Angeles											X	X
Richmond												
Washington, DC			X			X				X		
Fort Worth	X			X					X			
Raleigh	X			X					X			
Portland, ME	X	X		X	X							
Kansas City	X		X	X		X			X	X		X
San Antonio			X			X				X		
Philadelphia			X			X		X		X		X
New Orleans			X			X				X		X
Charleston			X			X				X		
Sacramento			X			X		X		X		X
Jacksonville												

TABLE 7.7

RESIDENTIAL CITY SELECTION FOR MODEL 1 (EIGHT VARIABLE/LINEAR) USING MAXIMUM BALANCE POINTS

DESIGN NAME	START 9	BEST 9		START(9)12	BEST(9)12		BEST 12		START(12)15		BEST 15	
START DESIGN	-	START 9		START 9	BEST 9		BEST(9)12		START(9)12		START(12)15	
ADD/EXCHANGE		EXCHANGE		ADD 3	ADD 3		EXCHANGE		ADD 3		EXCHANGE	
FIXED/RANDOM	F	F	R	F	F	R	F	R	F	R	F	R
G	2.0	30.5	14.1	23.8	56.7	27.9	77.5	76.9	47.3	64.2	86.8	72.4
D	50.4	3.3	7.1	3.2	1.3	2.7	1.0	1.0	1.3	0.9	0.7	0.8
CITIES												
Miami	X			X			X	X	X		X	
Bismarck	X	X		X	X		X	X	X	X	X	X
Phoenix	X	X	X	X	X	X	X	X	X	X	X	X
Great Falls					X	X	X	X	X	X	X	X
Seattle		X		X	X		X		X			
Brownsville		X			X	X	X	X	X	X	X	X
El Paso											X	X
San Diego		X	X	X	X	X	X	X	X	X	X	X
Lake Charles	X	X		X	X		X	X	X	X	X	X
San Francisco			X		X	X	X	X	X	X	X	X
Fresno						X	X	X		X	X	X
Burlington												
Oklahoma City											X	
Cheyenne												
Salt Lake City												
Albuquerque			X		X	X	X	X		X	X	X
Medford	X	X	X	X	X	X		X	X	X	X	X
Lubbock		X		X	X		X	X	X	X	X	X
Los Angeles												
Richmond												
Jacksonville												
Washington, DC												
Fort Worth	X			X					X			
Raleigh	X			X					X			
Portland, ME	X	X		X	X				X		X	
Kansas City	X			X					X			
Charleston			X			X				X		X
San Antonio			X			X				X		X
Omaha			X			X				X		
Dodge City			X			X				X		X

TABLE 7.8

RESIDENTIAL CITY SELECTION FOR MODELS 2, 3 AND 4 USING AVERAGE BALANCE POINTS

	MODEL 2				MODEL 3				MODEL 4			
DESIGN NAME	START 15	BEST 15	BEST(15)20	BEST 20	START 15	BEST 15	BEST(15)20	BEST 20	START 15	BEST 15	BEST(15)20	BEST 20
START DESIGN	-	START 15	BEST 15	BEST(15)20	-	START 15	BEST 15	BEST(15)20	-	START 15	BEST 15	BEST(15)20
ADD/EXCHANGE	-	EXCHANGE	ADD 5	EXCHANGE	-	EXCHANGE	ADD 5	EXCHANGE	-	EXCHANGE	ADD 5	EXCHANGE
FIXED/RANDOM	F	F	F	F	F	F	F	F	F	F	F	F
G	5.3	41.6	70.0	70.0	3.2	51.6	89.3	89.3	38.5	55.1	93.4	93.4
D	17.5	2.2	1.0	1.0	27.0	1.7	0.7	0.7	2.1	1.5	0.6	0.6
CITIES												
Burlington	X		X	X	X		X	X	X			
Lake Charles	X				X				X	X	X	
Phoenix	X	X	X	X	X	X	X	X	X	X	X	X
Cheyenne	X	X	X	X	X	X	X	X	X	X	X	X
Brownsville	X	X	X	X	X	X	X	X	X	X	X	X
San Diego	X	X	X	X	X	X	X	X	X	X	X	X
Oklahoma	X	X	X	X	X	X	X	X	X	X	X	X
Great Falls	X	X	X	X	X	X	X	X	X	X	X	X
Bismarck	X	X	X	X	X	X	X	X	X	X	X	X
Salt Lake City	X		X	X	X	X	X	X	X	X	X	X
San Francisco	X	X	X	X	X	X	X	X	X	X	X	X
Miami	X	X	X	X	X	X	X	X	X	X	X	X
Seattle	X	X	X	X	X	X	X	X	X	X	X	X
El Paso	X	X	X	X	X	X	X	X	X	X	X	X
Fresno	X	X	X	X	X	X	X	X	X	X	X	X
Richmond	X	X	X	X		X	X	X				
Jacksonville	X											
Medford	X											
Albuquerque	X		X	X			X	X		X	X	X
Washington, DC	X											
Lubbock		X	X	X		X	X	X			X	X
New Orleans		X	X	X								
Tampa			X	X			X	X				X
Portland, ME			X	X								
San Antonio							X	X				
Los Angeles							X	X			X	X
Madison											X	X
Fort Worth											X	X
Sacramento											X	X

D. Final Results

The residential final selection is made of those locations that were most recurrent across balance temperatures. These are listed below (also see figure 7-1).

Table 7.9

FINAL RESIDENTIAL SELECTION

1. Burlington
2. Lake Charles
3. Phoenix
4. Cheyenne
5. Brownsville
6. San Diego
7. Oklahoma City
8. Great Falls
9. Bismarck
10. Salt Lake City
11. San Francisco
12. Miami
13. Seattle
14. El Paso
15. Fresno

ADDITIONS

16. Richmond
17. Lubbock
18. Medford
19. Albuquerque
20. Los Angeles

As can be observed from Table 7.9 and Figure 7.1, the experimental design building process has selected points representing extreme climate conditions. This is mainly because the larger the spread of the independent variable observations, the smaller the variance of the regression coefficient.

Also, since the fifteen point selection for models 2, 3 and 4 yields d values above the suggested levels for prediction, five additional points are recommended. The resulting 20 point selection yields d and %G efficiency levels close to suggested levels.

No intermediate climates are required if the basic premise that relationships of the type described in the linear, linear interactive and quadratic models accurately depict the relationship between energy consumption in residential housing and the climate indicators developed for the analyses. Bearing in mind this caveat, this experimental design selection process yields a model with good prediction capability.

Attributes of the SFR climate selection include:

- Accurate statistical prediction of energy use for all locations.

- Coverage of the entire range of climate variation, this requires selected points at the extremes.

- Does not yield a sample which is stratified according to climate zones.

- Absence of redundancy among locations.

- Coverage for the entire range of variation of balance temperature and humidity points found in residential prototypes.

VIII: MOBILE HOME CLIMATE SELECTION

A. Objectives

This section discusses the proposed Mobile Homes Climate Selection. The objectives for the selection are listed below:

- Select locations throughout the 50 states to best represent the variation in possible combinations of climate variable ranges.
- Incorporate in the selection procedure data on the envelope sensitive characteristics of Mobile Homes.
- Provide maximum coverage in those areas with the greatest estimated growth of year-round occupied Mobile Homes without reducing statistical predictive ability.

The output of this climate selection is a ranked list of climate locations for Mobile Homes, having a proven statistical predictive value, for use in conducting energy simulations of Mobile Home energy behavior.

To fulfill the objectives of this climate analysis, a set of regression "experimental designs" was constructed using climate indicators derived from Mobile Homes balance points. The heating "balance point" for a mobile home is that temperature below which energy from the heating system is required to maintain the inside temperature to make up for heat losses to colder air outside. In general, the heating balance point gets lower as the following factors occur:

1. The mobile home gets "tighter" - more insulation, less infiltration;

2. Internal loads increase - more heat is generated inside the mobile home from people, appliances and lights.

The cooling balance point can be different (higher) than the heating balance point, since summer indoor set points and ventilation levels are higher than in the winter.

Using balance points allows for an accurate accumulation of the climate indicators for heating and cooling, separately, to input to the construction of the experimental design. These accumulations about the balance points are defined for both dry bulb temperature and humidity. The cumulative values of any given indicator are determined separately for heating and cooling by the balance point responding to the thermal profile of the range being analyzed. Also, dead bands are included to reflect gaps between indoor heating and cooling set points.

The factors that have been selected from the pool of variables determining the building hourly loads were Dry Bulb Temperature, Humidity, Wind Speed and Insolation. All climate indicators describing these factors are cumulative statistics derived from hourly data from test reference years (TRY) for each location, the same data that is used in estimating the building loads for the subsequent energy analyses (see Section 4 and 5 for more details).

The experimental design as such is constructed from either randomly selected candidate climate locations or user chosen candidate climate locations. Locations are added, substracted or exchanged utilizing "add" and ""exchange" algorithms which are part of a user interactive routine called ADDEXC.

The following paragraphs explain the process leading to the Mobile Homes final design. These include a discussion on the range of sensitivities mapped, along with the intermediate results obtained.

B. Method

This section describes the range of testing performed on those factors having a potential impact on the experimental design outputs. The mapped sensitivities are shown below:

TABLE 8.1

SENSITIVITY PLAN FOR MOBILE HOMES

FACTOR	VARIATION
Choice of Starting Design:	Fixed Random
Regression Model:	Linear with no interactions Linear with interactions Quadratic with no interactions
Temperature/Humidity: Balance Points	Minimum Range Average Range Maximum Range

These sensitivities are designed to test the full range of variation in the selection. Below is a more detailed description of these items. Actual results are presented in the following two sections.

1. Choice of Starting Design

Sensitivities both with respect to the choice of the starting design and the potential exchanges beyond the specified selection size were performed across the entire range of balance temperatures. The starting design can be set in one of two modes: fixed, i.e., locations chosen by the analyst upon some set of criteria, or random, i.e., chosen at random by the analysis program).

1.1 FIXED: The fixed starting design used for Mobile Homes resulted from the integration of: (1) the HUD Title VI preliminary climate selection, (2) previous cluster analyses by Control Data Corporation (CDC), (3) historical data on the estimated growth of year-round occupied Mobile Homes and (4) recommendations by the BEPS Climate Subcommittee. This preliminary selection is presented in Table 8.2.

1.2 RANDOM: The random starting design is chosen by randomly selected candidate climate locations.

TABLE 8.2

FIXED STARTING DESIGN FOR MOBILE HOMES

South Zone

TX-Dallas
AZ-Phoenix
NC-Raleigh
FL-Miami
LA-Lake Charles

North Zone and Alaska

MO-Kansas City
OR-Medford
ME-Portland
ND-Fargo (Bismarck)
AL-Anchorage

Previous experience on other building types has shown that <u>different</u> starting climate locations and <u>different</u> combinations of applying add and exchange operations yield final climate location selections with <u>similar</u> design statistics for fixed design sizes. Design points may end up being different (especially when the number of candidate points is large), however the design prediction properties will be similar.

2. Mobile Home Regression Models

The ADDEXC routine deals with experimental designs tailored to the regression model chosen by the user. The following three models were developed and tested for Mobil Homes: 1 - linear with no interactions; 2 - linear with interactions; and 3 - quadratic with no interactions.

1. Linear With No Interactions: Energy consumption assumed as a linear function of the following 8 independent variables:

$$E_1 = a_1 + a_2 HDH + a_3 CDH + a_4 HWH + a_5 CWH + a_6 HIH + a_7 CIH + a_8 HWSH + a_9 CWSH$$

where:

HDH: Heating degree hours
CDH: Cooling degree hours
HWH: Heating humidity ratio hours
CWH: Cooling humidity ratio hours
HIH: Heating insolation hours
CIH: Cooling insolation hours
HWSH: Heating wind speed hours
CWSH: Cooling wind speed hours

2. Linear With Interactions: Same as 1 above, but in addition, 5 cross products are included:

- Heating and cooling degree hours
- Heating degree hours and heating humidity ratio hours
- Cooling degree hours and cooling humidity ratio hours.
- Heating degree hours and heating insolation hours
- Cooling degree hours and cooling insolation hours

$$E_2 = a_1 + a_2HDH + a_3CDH + a_4HWH + a_5CWH + a_6HIH + A_7CIH + a_8HWSH + a_9CWSH + a_{10}HDH(CDH) + a_{11}HDH(HWH) + a_{12}CDH(CWH) + a_{13}HDH(HIH) + a_{14}CDH(CIH)$$

3. Quadratic With No Interations: Same as 1 above, but in addition 4 quadratic terms are included for the following factors:

-Heating humidity ratio hours
-Cooling humidity ratio hours
-Heating insolation hours
-Cooling insolation hours

$$E_3 = a_1 + a_2 HDH + a_3 CDH + a_4 HWH + a_5 CWH + a_6 HIH + A_7 CIH + a_8 HWSH + a_9 CWSH + a_{10} HWH^2 + a_{11} CWH^2 + a_{12} HIH^2 + a_{13} CIH^2$$

These models were specified to cover a wide range of likely models and submodels between Mobile Homes energy consumption and climate indicators. In fact, they encompass the regression curves developed by Lawrence Berkeley Laboratory for the single family budget selections. For electrically heated homes, the form of the regression was:

$$E_B = a_1 + a_2 HDD + a_3 HDD^2 + a_4 CDD$$

For gas heated/electrically air-conditioned homes:

$$Eh = a_1 + a_2 HDD^2 + HDD$$

$$Ec = a_4 + a_5 CDD$$

where:

E_b = energy budget

Ec = cooling energy budget

Eh = gas heating energy budget

a_1, a_2, a_3, a_4, a_5 = regression coefficients

For additional details on these regressions see the SFR section on Regression Models.

A priori, linear models provide adequate representation of the likely impact of climate factors on the energy consumption of Mobil Homes, for the following reasons:

- The systems involved in this type of application are single zone and for the most part coil and space loads can be assumed directly proportional.

- Temperature: Under steady-state conditions, conduction losses and gains are directly proportional to the in-outdoor temperature differences.

- Humidity: Latent loads (Q_L) and changes in humidity ratio (dW) are directly proportional. This is ordinarily expressed as:

  $$Q_L = 4840\ (CFM)\ dW$$

  Where:

  CFM: Airflow in cubic feet per minute

  dW: In-outdoor humidity ratio difference

- Wind speed: Infiltration is driven by pressure differences caused by wind speed and the temperature differences between the inside and the outside. Empirical results of infiltration have been statistically fit to simple equations which are typically linear in both wind speed and temperature differences. The Coblenz-Achenback equation, a simple multiple regression equation has produced observed results in several important cases and is as accurate and realistic as available today.

- Insolation: The shell of Mobil Homes is so light that thermal storage is not significant.

Limitations: Models 2 and 3 involve 13 and 14 regression coefficients and at least 20 cities need to be selected to predict with confidence. Since the size of the Mobil Home Climate Selection is fixed at 9 points, Model 1 was selected to perform balance point sensitivities. Models 2 and 3 were tested to determine if the set cities selected using Model 1 are a subset of the cities that would be selected with these more complete models.

3. Computation of Mobile Home Climate Indicators

These sensitivity analyses are designed to determine the extent to which the selection of climate locations was dependent on the prototype configuration or on the balance point used. Temperature balance points were generated for the minimum and maximum levels of insulation found in each one of three prototypes to be simulated, taking into account differences between the winter and summer indoor set points and solar loads.

Figure 8.1 and Tables 8.3, 8.4 and 8.5 show data inputs and resulting temperature balance points.

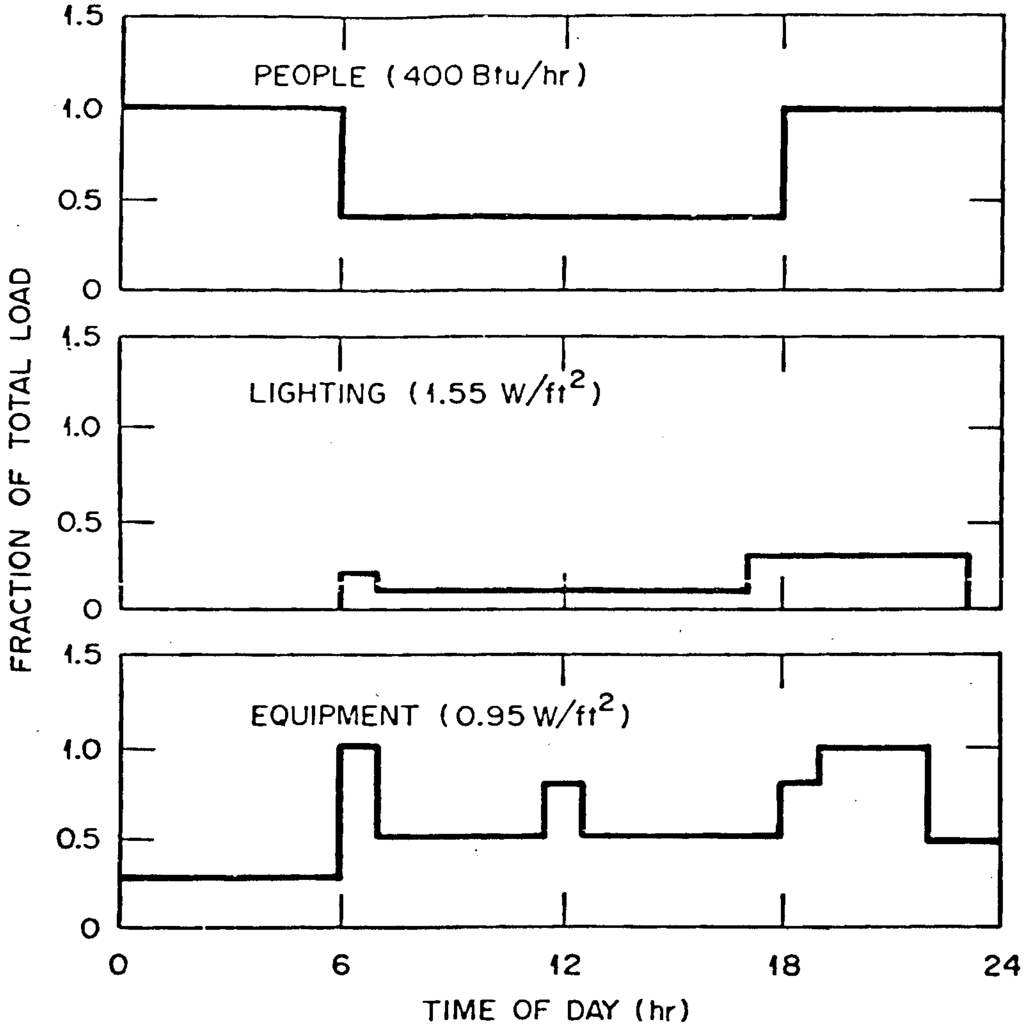


FIGURE 8.1 Internal Loads Schedules for Mobile Homes

Source: Oak Ridge National Laboratory
Engineering-Economic Analysis of Mobile Home
Thermal Performance (ORNL/CON-28)

TABLE 8.3*

RANGE OF COMPOSITE "U" VALVUES FOR MOBILE HOMES

	CLIMATE ZONE 1	CLIMATE ZONE 2	CLIMATE ZONE 3
PROTOTYPE: 12 X 56			
Low	.120	.094	.082
High	.094	.057	.054
PROTOTYPE: 14 x 66			
Low	.121	.096	.092
High	.097	.059	.056
PROTOTYPE: 24 x 56			
Low	.113	.082	.090
High	.087	.068	.065

*Source: Steven Winter and Associates

TABLE 8.4

MOBILE HOME BALANCE TEMPERATURE DATA INPUTS

PROTOTYPE	FLOOR AREA	EXPOSURE AREA	VOLUME Cu. Ft.	AREA OF GLAZING % of Floor Area	INFILTRATION BTU/Hr. F°
12 x 56	672	2364	5040	8	54.4
14 X 56	924	3048	6930	10	74.3
24 X 56	1344	3888	10080	10	108.9

Other Data:

Infiltration: .6 air changes/hour

Solar Heat Gain Factors (BTU/sq ft glass)

Winter: 12.3
Summer: 26.4

Percent Possible Sunshine:

Winter: 48
Summer: 68

Shading Coefficient: .7

1: Hourly average for 16 compass orientations for 40°N latitude

TABLE 8.5

TEMPERATURE BALANCE POINTS FOR MOBILE HOMES

Protytype:		°F
12 x 56		
U*= .12	W**	63
	S	69
u = .054	W	60
	S	62
14 x 66		
u = .121	W	64
	S	70
u = .56	W	58
	S	63
24 x 56		
u = .133	W	61
	S	67
u = .65	W	56
	S	61

RANGE:	W	S
Min.	56	61
Av.	60	66
Max.	64	70

* Shell composite coefficient of heat transfer

** W: Winter, S: Summer

Humidity balance points and dead bands were generated crediting internal latent heat gains and accounting for changes in air flow (See Table 8.6).

TABLE 8.6

HUMIDITY BALANCE POINTS AND DEAD BANDS FOR MOBILE HOMES

(Moisture per # of Dry Air)

Min.	.00435	.00994
Av.	.00441	.01000
Max.	.00445	.01004

A more detailed presentation of the equations for these calculations can be found in section 5.

These balance points determine the range of sensitivities testing the impact of prototype configuration. The resulting data inputs to the experimental design are as follows:

- Heating Degree Hours (HDH) at bases 56, 60 and 64°F.
- Cooling Degree Hours (CDH) at bases 61, 66 and 70°F.
- Heating Humidity Ratio Hours (HWH) at bases .00435, .00441 and .00445 pounds of moisture per pounds of dry air.
- Cooling Humidity Ratio Hours (CWH) at bases .00994, .100 and .1004 pounds of moisture per pound of dry air.
- Heating Insolation Hours (HIS) for the hours below 56, 60, and 64°F.
- Cooling Insolation Hours (CIS) for the hours above 61, 66 and 70°F.
- Heating Wind Speed Hours (HWSH) for the hours below 56, 60 and 64°F.
- Cooling Wind Speed Hours (CWSH) for the hours above 61, 66 and 70°F.

The following two sections provide results for the entire range of sensitivities just described.

C. Intermediate Results

This section discusses the Mobile Homes climate sensitivity results.

Once a starting design (an initial set of climate locations) is chosen, the Mobile Home Climate Selection proceeds by either adding or exchanging locations. The choice of which new candidate climate location to add or exchange is determined by a prediction variance criterion. A detailed account of this procedure can be found in Section V (A).

Tables 8.7 - 8.10 show the outcome of this selection process for all sensitivities. Overall, the Mobile Home climate selection was quite stable across the entire sensitivity range. As the number of cities in a design increase, the stability of the cities reoccuring across models increases. For nine cities the models are more sensitive to specific city combinations.

From the standpoint of each sensitivity factor the following observations can be made:

- Variations in prototype configuration or balance point do not have a significant impact on the climate selection. If we compare across balance point ranges for the fixed design, the number and the spread of the changes that occurred was very limited, as shown below:

  Fixed Design Changes Across Balance Points

  1- Brownsville, Miami
  2- San Francisco, Seattle
  3- Miami, Lake Charles, Oklahoma City.

TABLE 8.7

MOBILE HOME CITY SELECTION FOR MODEL 1 (EIGHT VARIABLE/LINEAR) USING MINIMUM BALANCE POINTS

DESIGN NAME	START 9	BEST 9		START(9)12	BEST(9)12		BEST 12		START(12)15		BEST 15	
START DESIGN	START 9	START 9		START 9	BEST 9		BEST(9)12		START(9)12		START(12)15	
ADD/EXCHANGE	-	EXCHANGE		ADD 3	ADD 3		EXCHANGE		ADD 3		EXCHANGE	
FIXED/RANDOM	-	F	R	F	F	R	F	R	F	R	F	R
G	1.3	20.8	44.5	23.2	40.0	66.5	69.7	66.5	49.4	78.5	72.0	78.9
D	75.0	4.8	2.2	3.2	1.9	1.1	1.1	1.1	1.2	0.8	0.8	0.8
CITIES												
Phoenix	X	X	X	X	X	X	X	X	X	X	X	X
Bismarck	X	X	X	X	X	X	X	X	X	X	X	X
Seattle			X		X	X	X	X	X	X	X	X
Albuquerque			X			X	X	X	X	X	X	X
San Diego		X		X	X		X		X	X	X	X
Lake Charles	X			X					X		X	
Miami	X	X	X	X	X	X	X	X	X	X	X	X
Great Falls		X	X	X	X	X	X	X	X	X	X	X
Lubbock		X		X	X		X		X	X	X	X
Brownsville						X	X	X	X	X	X	X
Fresno						X	X	X		X	X	X
San Francisco					X							X
El Paso					X	X	X	X		X	X	X
Portland, ME	X	X		X	X		X		X		X	
Los Angeles			X			X		X		X	X	X
Dallas	X	X		X	X				X			
Raleigh	X			X					X			
Medford	X	X		X	X				X		X	
Kansas City	X			X					X			
Burlington			X			X		X		X		X
Oklahoma City			X			X		X		X		
Richmond										X		X

TABLE 8.8

MOBILE HOME CITY SELECTION FOR MODEL 1 (EIGHT VARIABLE/LINEAR) USING AVERAGE BALANCE POINTS

DESIGN NAME	START 9	BEST 9		START(9)12	BEST(9)12		BEST 12		START(12)15		BEST 15	
START DESIGN	START 9	START 9		START 9	BEST 9		BEST(9)12		START(9)12		START(12)15	
ADD/EXCHANGE	-	EXCHANGE		ADD 3	ADD 3		EXCHANGE		ADD 3		EXCHANGE	
FIXED/RANDOM	F	F	R	F	F	R	F	R	F	R	F	R
G	1.8	33.1	30.9	17.4	69.2	58.1	74.6	65.0	50.4	78.2	84.1	78.2
D	55.3	3.0	3.2	4.3	1.1	1.3	1.0	1.2	1.2	0.8	0.7	0.8
CITIES												
Phoenix	X	X	X	X	X	X	X	X	X	X	X	X
Bismarck	X	X	X	X	X	X	X	X	X	X	X	X
Seattle		X			X	X	X	X		X	X	X
Albuquerque							X		X	X	X	X
San Diego		X	X	X	X	X	X	X	X	X	X	X
Lake Charles	X	X		X	X		X		X		X	
Miami	X			X				X	X	X	X	X
Great Falls		X	X	X	X	X	X	X	X	X	X	X
Lubbock		X		X	X		X		X		X	
Brownsville		X	X		X	X	X	X	X	X	X	X
Fresno					X	X	X	X		X	X	X
San Francisco			X		X	X	X	X	X	X	X	X
El Paso					X	X	X	X		X	X	X
Portland, ME	X	X		X	X				X	X	X	X
Los Angeles											X	
Dallas	X			X					X			
Raleigh	X			X					X			
Medford	X			X					X			
Kansas City	X			X					X			
Cheyenne			X			X		X		X		X
Amarillo			X			X		X		X		X
Tampa			X			X				X		X

TABLE 8.9

MOBILE HOME CITY SELECTION FOR MODEL 1 (EIGHT VARIABLE/LINEAR) USING MAXIMUM BALANCE POINTS

DESIGN NAME	START 9	BEST 9		START(9)12	BEST(9)12		BEST 12		START(12)15		BEST 15	
START DESIGN	START 9	START 9		START 9	BEST 9		BEST(9)12		START(9)12		START(12)15	
ADD/EXCHANGE	-	EXCHANGE		ADD 3	ADD 3		EXCHANGE		ADD 3		EXCHANGE	
FIXED/RANDOM	F	F	R	F	F	R	F	R	F	R	F	R
G	1.9	31.7	38.0	15.0	62.8	62.1	74.0	75.1	51.1	84.6	82.5	84.6
D	52.3	3.2	2.6	5.0	1.2	1.2	1.0	1.0	1.2	0.7	0.7	0.7
CITIES												
Phoenix	X	X	X	X	X	X	X	X	X	X	X	X
Bismarck	X		X	X		X	X	X	X	X	X	X
Seattle					X		X	X		X	X	X
Albuquerque						X		X	X	X	X	X
San Diego		X	X	X	X	X	X	X	X	X	X	X
Lake Charles	X			X		X	X	X	X	X	X	X
Miami	X	X		X	X			X	X		X	
Great Falls		X	X		X	X	X	X	X	X	X	X
Lubbock		X		X	X	X	X	X	X	X	X	X
Brownsville		X	X		X	X	X	X	X	X	X	X
Fresno			X		X	X	X	X		X	X	X
San Francisco		X	X	X	X	X	X	X	X	X	X	X
El Paso			X		X	X	X			X	X	X
Portland, ME	X	X		X	X		X		X	X	X	X
Los Angeles												
Dallas	X			X					X			
Raleigh	X			X					X			
Medford	X	X		X	X				X	X		X
Kansas City	X			X							X	
Oklahoma City											X	
Tampa			X			X				X		X

TABLE 8.10

MOBILE HOME CITY SELECTION FOR MODEL 2 (INTERACTION) AND MODEL 3 (QUADRATIC) USING AVERAGE BLANCE POINTS

	MODEL 2				MODEL 3			
DESIGN NAME	START 15	BEST 15	BEST(15)20	BEST 20	START 15	BEST 15	BEST(15)20	BEST 20
START DESIGN	-	START 15	BEST 15	BEST(15)20	-	START 15	BEST 15	BEST(15)20
ADD/EXCHANGE	-	EXCHANGE	ADD 5	EXCHANGE	-	EXCHANGE	ADD 5	EXCHANGE
G	13.4	33.5	75.2	80.3	19.4	39.6	82.6	82.6
D	7.0	2.8	0.9	0.9	4.5	2.2	0.8	0.8
CITIES								
Phoenix	X	X	X	X	X	X	X	X
Bismarck	X	X	X	X	X	X	X	X
Seattle	X	X	X	X	X	X	X	X
Albuquerque	X				X	X	X	X
San Diego	X	X	X	X	X	X	X	X
Lake Charles	X	X	X	X	X	X	X	X
Miami	X	X	X	X	X	X	X	X
Great Falls	X	X	X	X	X	X	X	X
Lubbock	X	X	X	X	X	X	X	X
Brownsville	X	X	X	X	X	X	X	X
Fresno	X	X	X		X	X	X	X
San Francisco	X	X	X	X	X	X	X	X
El Paso	X	X	X	X	X	X	X	X
Portland, ME	X		X	X	X			
Los Angeles	X				X			
Cheyenne		X	X	X			X	X
Oklahoma City		X	X	X		X	X	X
Salt Lake City		X	X	X		X	X	X
Richmond			X	X			X	X
Tampa			X	X			X	X
Burlington			X	X			X	X
Dallas			X	X			X	X
Sacramento				X				

- The modeling tests show that the 8 variable linear model selection is a subset of the selection from more comprehensive models such as the quadratic and interactions models.
- The impact of the choice of starting design proved to be relatively insignificant given that there was not a marked difference in the statistical properties of either choice, even though the random design showed a slightly better performance. It is worth noticing that the cities that switched from random to fixed starting designs also changed as cities were added. These switches took place because of the very similar prediction variances of these points.

An evaluation across models led to the recurrent cities presented in Table 8.11.

TABLE 8.11

MOBILE HOME SENSITIVITIES: RECURRENT POINTS

Phoenix	Brownsville
Bismarck	Fresno
Seattle	El Paso
Albuquerque	Los Angeles
San Diego	San Francisco
Lake Charles	Portland, ME
Miami	
Great Falls	
Lubbock	

D. Final Results

Given the sensitivity analyses results above, this section discusses the criteria and process leading to the Final Mobile Home Climate Selection.

Two criteria were used to choose any given location:

- High recurrence across modeling, balance points and starting design sensitivities.
- High growth of year-round occupied Mobile Homes.

Also, two constraints were imposed:

- Due to budget limitations the selection size was limited to 10 locations.
- At least one site had to be located in Alaska. Climate data was not available for this state.

To accommodate the two criteria mentioned above, a few changes had to be made to the list of most recurrent points:

- Switch Lubbock to Atlanta: besides presenting a quite extreme humid condition, Atlanta encompasses a very large number of similar cities such as AL-Birmingham, NC-Raleigh, TN-Memphis, TN-Nashville and VA-Richmond.
- Switch Great Falls to Washington, D.C.: Washington, D. C. represents climates typical of north and central eastern states. Great Falls represents extreme weather conditions similar to Bismarck and hence was excluded.

Table 8.11, above, lists the most recurrent locations, Table 8.12 below shows the areas with the highest growth of year-round occupied Mobile Homes. The final selection is shown in Table 8.13 below.

TABLE 8.13

MOBILE HOME FINAL SELECTION

	Selection	Possible Exchanges
Region 1	• PHOENIX	
	• MIAMI	Brownsville, Tampa
	• ALBUQUERQUE	
	• SAN DIEGO	Los Angeles
	• ATLANTA	
	• LAKE CHARLES	
Region 2	• SEATTLE	San Francisco
	• BISMARCK	Fargo
	• WASHINGTON DC	
Region 3	• ANCHORAGE	
		Possible Adds:
		Great Falls
		Lubbock
		Fresno
		El Paso
		Portland, ME

When comparisons of interpolated rather than observed values are to be made, the above exchanges are not recommended. Even though the inclusion of Anchorage was not tested due to the non availability of data for

TABLE 8.12

ESTIMATED GROWTH OF YEAR-ROUND OCCUPIED MOBILE HOMES
1972 - 1977

Number of Trailers by State

TX	57,416	IO	9,489
FL	44,426	IN	7,850
CA	41,536	MT	6,571
WA	31,657	IA	5,710
NC	30,801	UT	5,253
LA	25,736	NO	5,211
OR	24,948	NV	4,091
GA	23,157	WY	4,064
SC	23,157	WY	4,064
PA	22,250	NE.	4,058
AL	17,264	DE	4,018
AZ	17,210	AK	2,889
KY	16,484	SD	2,559
MS	16,310	ME	2,151
NM	14,649	MO	2,076
MN	14,440	CO	2,030
TN	13,729	NH	1,549
OH	13,088	NJ	1,535
MI	12,712	MA	713
AR	11,858	RI	31
MO	11,789	HI	27
WV	11,732	CT	240
IL	11,161	VT	388
VA	10,700		
KS	10,577		
WI	10,378		
OK	10,246		

Alaska, it is thought that this is not a serious drawback since this city represents an extreme condition compared to other cities in the candidate set ensuring its most likely selection.

As can be observed from the experimental design building process has selected points representing extreme climate conditions. This is mainly because the larger the spread of the independent variable observations, the smaller the predictive variance of the regression coefficients.

No intermediate climates are required if the hypothesis is correct that the relationships of the type described in the linear, linear-interactive and quadratic models accurately depict the relationship between energy consumption in Mobile Homes and the climate indicators developed for the analyses. Bearing in mind this caveat, this experimental design selection process yields a model with good predictive capability.

The hypothesis can be checked by 1) predicting the energy performance of one or more intermediate climate locations by using the regression model (s) from the climate selection procedure, and 2) comparing the results of step one with the results obtained by conducting energy simulations at the same locations using the full hour by hour TRY data.

Attributes of the Final Selection:

- Accurate statistical prediction of energy use for all locations.
- High correspondence with areas where the estimated growth of year-round mobile homes is concentrated.

- Coverage of the entire range of climate variation: This requires selected points at the extremes.
- Does not yield a sample which is stratified according to climate zones.
- Absence of redundancy among locations.
- Coverage for the entire range of variation of balance temperature and humidity points found in Mobile Homes.

APPENDIX A: TRY Site Climate Indicators

TRY SITE COMMERCIAL CLIMATE INDICATORS
FOR HEATING DEGREE BASE 40
AND HEATING HUMIDITY RATIO BASE 0.00468

WBAN	TRY SITE	HOURS BELOW BASE	DEGREE HOURS	INSOL ATION HOURS	WIND SPEED HOURS	HUMID RATIO HOURS	AVE DAILY MIN	ANN UAL MIN
24011	BISMARC	4391	91254	105	38185	11.7	29	-34
14742	BURLING	3597	59717	84	27672	9.5	34	-19
24018	CHEYENE	3275	42189	88	37798	8.5	35	-17
14764	PORT/ME	3540	47510	94	23399	9.3	35	-11
24143	GREATF	3311	51884	75	46404	8.4	35	-23
14922	MINNEAP	3839	74978	107	33852	10.8	35	-30
14837	MADISON	3629	51074	79	27752	7.7	36	-18
14735	ALBANY	3439	49920	88	28448	8.4	37	-20
24127	SALTLA	3087	34818	77	21878	5.7	39	-4
14733	BUFFALO	3377	39990	78	35703	7.2	39	0
14942	OMAHA	2769	43863	72	22555	7.4	40	-17
24131	BOISE	2664	24393	56	17284	4.7	40	3
94847	DETROIT	2992	41245	71	28386	7.4	40	-8
24225	MEDFORD	1808	10722	25	3695	1.8	41	19
14820	CLEVELA	3128	38853	71	29880	8.0	41	0
14819	CHICAGO	2951	33432	71	24080	6.1	42	-8
94823	PITTSBU	2811	29143	63	25159	5.7	42	-6
93819	INDIANA	2824	35235	75	25309	6.0	42	-19
13985	DODGEC	2557	32049	65	27432	5.3	42	-8
24233	SEATTLE	1502	7790	20	10853	1.8	43	24
24229	PORT/OR	1570	9345	19	13096	2.0	44	22
14739	BOSTON	2815	27312	82	35349	6.8	44	7
23047	AMARILL	1831	18579	47	20618	3.8	44	3
13983	COLUMBI	2358	30299	62	22091	5.8	45	-11
13994	STLOUI	2426	29173	63	20994	4.7	45	-7
23050	ALBUQUE	1857	15240	63	11975	4.0	45	5
93814	CINCINN	2315	21503	56	19676	4.8	45	-5
13739	PHILADE	2632	23923	73	26488	6.7	45	11
13988	KANSAS	2354	29124	60	19875	5.7	46	-7
23042	LUBBOCK	1617	14990	41	18269	3.7	46	7
13740	RICHMON	2195	18195	61	14840	4.9	46	9
93821	LOUISVI	1980	19703	54	16216	4.3	47	-7
23232	SACRAME	710	3671	13	2889	0.8	47	25
14732	NEWYOR	1845	15830	49	24774	4.6	48	9
13722	RALEIGH	1420	12358	39	9778	3.1	48	9
93193	FRESNO	615	2942	5	2497	0.4	48	26
23234	SANFRA	94	229	1	462	0.1	49	32
13967	OKLAHOM	1677	18839	42	24028	3.8	49	-1
13897	NASHVIL	1279	11074	33	10020	2.7	49	-1
13743	WASHING	1590	11764	37	12581	3.2	50	9
23044	ELPASO	993	7664	21	5334	2.6	50	10
13968	TULSA	1377	15427	35	10991	2.8	50	0
13737	NORFOLK	1125	8283	28	10795	2.4	51	18
13876	BIRMING	1038	8695	24	5345	1.9	51	8
13893	MEMPHIS	1146	9908	32	7751	2.3	51	13
13874	ATLANTA	1031	6747	25	9219	2.1	52	14
3940	JACK/MS	764	5449	17	4957	1.4	54	15
13880	CHARLES	723	4242	11	5721	1.3	54	18
23174	LOSANG	4	9	0	13	0.0	55	37
3927	FORTWO	686	4071	15	5841	1.4	55	19
23183	PHOENIX	309	1413	2	822	0.4	56	26
23188	SANDIE	3	5	0	4	0.0	57	38
12921	SANANT	433	2380	7	3505	0.6	58	23
3937	LAKECH	395	1869	7	2914	0.5	59	22
12918	HOUSTON	368	2053	9	3480	0.7	60	20
13889	JACK/FL	184	935	4	1275	0.3	60	27
12916	NEWORL	329	1463	12	3650	0.7	60	25
12842	TAMPA	13	20	0	128	0.0	64	37
12919	BROWNSV	17	41	0	150	0.0	66	36
12839	MIAMI	10	28	0	74	0.0	70	36

TRY SITE COMMERCIAL CLIMATE INDICATORS
FOR HEATING DEGREE BASE 45
AND HEATING HUMIDITY RATIO BASE 0.00468

WBAN	TRY SITE	HOURS BELOW BASE	DEGREE HOURS	INSOL ATION HOURS	WIND SPEED HOURS	HUMID RATIO HOURS	AVE DAILY MIN	ANN UAL MIN
24011	BISMARC	4940	114825	125	42980	12.1	29	-34
14742	BURLING	4299	79898	102	33501	10.1	34	-19
24018	CHEYENE	4227	61672	124	48609	9.9	35	-17
14764	PORT/ME	4354	67693	123	29489	10.0	35	-11
24143	GREATF	4059	70655	98	59142	9.6	35	-23
14922	MINNEAP	4380	95919	124	39353	11.2	35	-30
14837	MADISON	4167	70862	97	32116	8.0	36	-18
14735	ALBANY	4048	68981	103	32363	8.8	37	-20
24127	SALTLA	3853	52551	101	28257	6.3	39	-4
14733	BUFFALO	4037	58817	98	42895	7.6	39	0
14942	OMAHA	3380	59465	91	28125	8.0	40	-17
24131	BOISE	3595	40676	81	24332	5.5	40	3
94847	DETROIT	3570	58077	89	33496	7.9	40	-8
24225	MEDFORD	2953	23196	49	7209	2.1	41	19
14820	CLEVELA	3759	56558	91	35472	8.6	41	0
14819	CHICAGO	3688	50560	94	30436	6.6	42	-8
94823	PITTSBU	3440	45056	83	30982	6.3	42	-6
93819	INDIANA	3496	51342	93	31242	6.4	42	-19
13985	DODGEC	3149	46593	89	33887	6.0	42	-8
24233	SEATTLE	2907	19264	45	23173	2.3	43	24
24229	PORT/OR	2631	20191	37	21167	2.4	44	22
14739	BOSTON	3366	43068	106	41993	7.4	44	7
23047	AMARILL	2596	29974	69	29628	4.6	44	3
13983	COLUMBI	2905	43795	76	27196	6.3	45	-11
13994	STLOUI	3037	43064	84	26330	5.1	45	-7
23050	ALBUQUE	2680	27055	100	18477	5.2	45	5
93814	CINCINN	2956	35161	77	25592	5.5	45	-5
13739	PHILADE	3224	38900	95	31950	7.4	45	11
13988	KANSAS	2923	42692	78	24401	6.2	46	-7
23042	LUBBOCK	2175	24777	64	25742	4.5	46	7
13740	RICHMON	2877	31296	84	19251	5.6	46	9
93821	LOUISVI	2703	31794	76	21941	4.8	47	-7
23232	SACRAME	1452	9329	28	5637	0.9	47	25
14732	NEWYOR	2570	27369	74	33849	5.4	48	9
13722	RALEIGH	2039	21292	60	14282	3.9	48	9
93193	FRESNO	1284	7981	14	5644	0.5	48	26
23234	SANFRA	606	2183	8	3128	0.3	49	32
13967	OKLAHOM	2258	28966	64	31691	4.4	49	-1
13897	NASHVIL	2048	19870	53	16374	3.3	49	-1
13743	WASHING	2488	22347	65	20188	4.2	50	9
23044	ELPASO	1489	14126	39	8180	3.6	50	10
13968	TULSA	1885	23818	50	15183	3.2	50	0
13737	NORFOLK	1785	15840	50	17152	3.0	51	18
13876	BIRMING	1501	15265	36	7614	2.3	51	8
13893	MEMPHIS	1736	17392	51	12216	2.8	51	13
13874	ATLANTA	1624	13602	43	14483	2.7	52	14
3940	JACK/MS	1282	10720	33	8594	1.9	54	15
13880	CHARLES	1121	9003	22	8963	1.6	54	18
23174	LOSANG	51	153	0	207	0.1	55	37
3927	FORTWO	1242	9160	33	10750	2.0	55	19
23183	PHOENIX	662	3966	5	1951	0.7	56	26
23188	SANDIE	33	100	0	67	0.1	57	38
12921	SANANT	961	5931	18	8095	0.9	58	23
3937	LAKECH	817	5063	16	6431	0.7	59	22
12918	HOUSTON	712	4892	18	6752	0.9	60	20
13889	JACK/FL	418	2475	10	3043	0.5	60	27
12916	NEWORL	720	4163	25	7770	1.0	60	25
12842	TAMPA	95	289	0	653	0.1	64	37
12919	BROWNSV	129	420	2	1551	0.2	66	36
12839	MIAMI	24	106	0	180	0.0	70	36

TRY SITE COMMERCIAL CLIMATE INDICATORS
FOR HEATING DEGREE BASE 50
AND HEATING HUMIDITY RATIO BASE 0.00468

WBAN	TRY SITE	HOURS BELOW BASE	DEGREE HOURS	INSOL ATION HOURS	WIND SPEED HOURS	HUMID RATIO HOURS	AVE DAILY MIN	ANN UAL MIN
24011	BISMARC	5400	140854	143	46837	12.2	29	-34
14742	BURLING	4895	103181	121	38560	10.4	34	-19
24018	CHEYENE	4968	85108	160	56425	10.9	35	-17
14764	PORT/ME	5066	91708	154	34292	10.5	35	-11
24143	GREATF	4792	93142	122	71351	10.6	35	-23
14922	MINNEAP	4842	119232	141	43519	11.3	35	-30
14837	MADISON	4736	93316	117	36335	8.2	36	-18
14735	ALBANY	4608	90906	121	35892	9.0	37	-20
24127	SALTLA	4430	73569	126	33673	6.6	39	-4
14733	BUFFALO	4647	80871	117	49042	7.8	39	0
14942	OMAHA	4040	78412	115	33916	8.4	40	-17
24131	BOISE	4337	60959	112	30462	6.1	40	3
94847	DETROIT	4221	77871	107	39012	8.2	40	-8
24225	MEDFORD	3990	41113	77	11242	2.4	41	19
14820	CLEVELA	4292	76838	108	39867	8.8	41	0
14819	CHICAGO	4218	70643	117	35250	6.9	42	-8
94823	PITTSBU	4037	64036	102	35947	6.5	42	-6
93819	INDIANA	4010	70481	109	35882	6.6	42	-19
13985	DODGEC	3786	64228	116	40860	6.4	42	-8
24233	SEATTLE	4340	38346	78	36112	2.5	43	24
24229	PORT/OR	3964	37306	68	31736	2.6	44	22
14739	BOSTON	4005	61791	128	50430	7.8	44	7
23047	AMARILL	3283	45026	97	37779	5.2	44	3
13883	COLUMBI	3405	59872	93	31820	6.5	45	-11
13994	STLOUI	3588	59895	105	31200	5.4	45	-7
23050	ALBUQUE	3457	42807	147	24280	6.3	45	5
93814	CINCINN	3558	51763	98	31040	6.0	45	-5
13739	PHILADE	3755	56660	115	36579	7.8	45	11
13988	KANSAS	3397	58673	97	28171	6.4	46	-7
23042	LUBBOCK	2729	37329	90	33028	5.2	46	7
13740	RICHMON	3434	47326	108	23065	6.0	46	9
93821	LOUISVI	3369	47398	93	27011	5.1	47	-7
23232	SACRAME	2447	19599	52	10844	1.0	47	25
14732	NEWYOR	3373	42626	105	43012	5.9	48	9
13722	RALEIGH	2710	33427	88	19101	4.5	48	9
93193	FRESNO	2320	17406	39	11030	0.5	48	26
23234	SANFRA	1819	8188	29	11271	0.5	49	32
13967	OKLAHOM	2867	42036	89	40191	4.9	49	-1
13897	NASHVIL	2648	31995	76	21137	3.7	49	-1
13743	WASHING	3212	37035	94	26198	4.8	50	9
23044	ELPASO	2024	23158	64	11510	4.6	50	10
13968	TULSA	2583	35253	75	21099	3.4	50	0
13737	NORFOLK	2530	27100	81	24035	3.4	51	18
13876	BIRMING	2045	24382	56	10291	2.6	51	8
13893	MEMPHIS	2315	27816	74	16602	3.2	51	13
13874	ATLANTA	2237	23647	66	19567	3.0	52	14
3940	JACK/MS	1842	18847	52	12330	2.2	54	15
13880	CHARLES	1699	16280	42	14051	2.0	54	18
23174	LOSANG	329	1104	3	1524	0.2	55	37
3927	FORTWO	1868	17328	58	15949	2.4	55	19
23183	PHOENIX	1249	8920	14	4131	1.1	56	26
23188	SANDIE	260	791	4	674	0.3	57	38
12921	SANANT	1530	12506	35	13257	1.2	58	23
3937	LAKECH	1312	10591	28	10021	0.9	59	22
12918	HOUSTON	1153	9743	29	10677	1.1	60	20
13889	JACK/FL	771	5528	19	5583	0.7	60	27
12916	NEWORL	1229	9348	42	12739	1.4	60	25
12842	TAMPA	246	1179	3	1696	0.1	64	37
12919	BROWNSV	320	1589	5	3835	0.2	66	36
12839	MIAMI	62	338	2	486	0.0	70	36

TRY SITE COMMERCIAL CLIMATE INDICATORS
FOR COOLING DEGREE BASE 50
AND COOLING HUMIDITY RATIO BASE 0.01000

WBAN	TRY SITE	HOURS ABOVE BASE	DEGREE HOURS	INSOL ATION HOURS	WIND SPEED HOURS	HUMID RATIO HOURS	AVE DAILY MAX	ANN UAL MAX
24011	BISMARC	3232	58389	290	29858	2.5	51	102
14742	BURLING	3711	53793	236	30750	2.8	53	98
14922	MINNEAP	3824	72990	267	34116	6.1	53	97
14764	PORT/ME	3525	50072	279	25919	2.8	54	93
14733	BUFFALO	3988	59354	245	40086	2.8	55	89
14837	MADISON	3862	60066	252	31886	3.3	55	96
24143	GREATF	3767	54588	306	46371	0.0	55	93
14735	ALBANY	3997	63131	258	27156	5.7	56	92
14820	CLEVELA	4335	70228	285	34843	5.5	56	91
14739	BOSTON	4548	70473	303	56129	5.2	57	94
24233	SEATTLE	4144	40159	243	34720	0.1	57	98
24018	CHEYENE	3635	53951	350	36420	0.1	58	89
14819	CHICAGO	4418	73106	298	38818	4.4	58	99
94847	DETROIT	4409	72688	312	36986	6.3	58	93
94823	PITTSBU	4593	76826	298	36205	6.0	60	92
24229	PORT/OR	4582	54959	281	29950	0.1	60	99
93819	INDIANA	4637	83275	295	36481	8.6	60	93
14942	OMAHA	4588	85437	345	40369	9.0	61	98
13739	PHILADE	4886	89408	321	39050	10.0	61	94
24127	SALTLA	4193	81239	384	38769	0.2	62	100
14732	NEWYOR	5198	86675	328	51484	7.0	62	93
24131	BOISE	4300	75597	391	31823	0.1	63	102
23234	SANFRA	6491	55021	500	65266	0.1	63	89
93814	CINCINN	5058	92762	304	40550	8.7	63	96
13983	COLUMBI	5230	96697	339	45448	9.8	63	95
13994	STLOUI	5070	100816	348	39852	11.9	64	97
93821	LOUISVI	5251	98312	338	40446	9.4	64	94
13988	KANSAS	5247	105772	358	46544	10.7	64	98
13985	DODGEC	4823	96349	392	55886	4.7	65	105
13743	WASHING	5376	104086	352	47234	8.9	65	100
13740	RICHMON	5220	98567	359	31540	14.1	65	96
24225	MEDFORD	4557	70583	380	25057	0.0	66	100
13737	NORFOLK	6032	110238	395	52739	14.4	68	95
23174	LOSANG	8303	99337	506	54644	3.1	68	96
23050	ALBUQUE	5166	99844	472	42707	1.5	68	97
23188	SANDIE	8389	114953	523	51232	3.5	69	90
13968	TULSA	5990	119156	414	55409	16.7	69	97
13897	NASHVIL	5995	115313	392	46508	15.2	69	93
13722	RALEIGH	5910	107289	399	41506	13.5	69	93
23047	AMARILL	5339	101129	453	65798	5.7	69	104
13967	OKLAHOM	5742	120539	401	79116	15.6	70	105
13874	ATLANTA	6378	116624	366	43821	17.9	70	93
13893	MEMPHIS	6312	130412	427	44679	19.4	71	101
23232	SACRAME	6094	94161	494	38214	0.6	72	104
13876	BIRMING	6585	126721	398	37688	18.6	72	93
23042	LUBBOCK	5899	121130	529	74058	8.7	73	100
13880	CHARLES	6921	140835	449	65622	22.5	74	94
12916	NEWORL	7413	158778	457	61415	27.2	74	94
3940	JACK/MS	6812	148149	449	52097	21.9	75	98
3927	FORTWO	6764	151943	450	56016	18.5	75	99
23044	ELPASO	6611	142702	554	52736	2.6	76	99
93193	FRESNO	6179	120906	550	37948	0.7	76	107
3937	LAKECH	7334	160153	445	51560	29.5	76	96
12918	HOUSTON	7470	164854	445	63058	28.5	76	96
12921	SANANT	7143	164517	453	60511	25.5	77	103
13889	JACK/FL	7903	169409	497	61510	25.5	78	95
12842	TAMPA	8474	194206	544	72359	33.8	80	95
12839	MIAMI	8685	228738	531	67299	44.5	82	91
12919	BROWNSV	8385	210529	529	92058	41.7	82	94
23183	PHOENIX	7377	185023	622	31951	6.2	84	111

TRY SITE COMMERCIAL CLIMATE INDICATORS
FOR COOLING DEGREE BASE 57
AND COOLING HUMIDITY RATIO BASE 0.01007

WBAN	TRY SITE	HOURS ABOVE BASE	DEGREE HOURS	INSOLATION HOURS	WIND SPEED HOURS	HUMID RATIO HOURS	AVE DAILY MAX	ANNUAL MAX
24011	BISMARC	2562	37808	259	24363	2.4	51	102
14742	BURLING	2667	30981	195	22238	2.7	53	98
14922	MINNEAP	3181	47938	239	28613	5.9	53	97
14764	PORT/ME	2495	28471	229	19240	2.7	54	93
14733	BUFFALO	3075	34029	211	31222	2.7	55	89
14837	MADISON	2943	35738	217	24864	3.2	55	96
24143	GREATF	2604	31609	258	30660	0.0	55	93
14735	ALBANY	3091	37698	220	21105	5.6	56	92
14820	CLEVELA	3361	42723	250	26812	5.4	56	91
14739	BOSTON	3571	41622	256	43979	5.1	57	94
24233	SEATTLE	2075	17846	176	17200	0.1	57	98
24018	CHEYENE	2606	31564	286	25793	0.0	58	89
14819	CHICAGO	3507	44783	260	31133	4.3	58	99
94847	DETROIT	3505	44522	274	29863	6.2	58	93
94823	PITTSBU	3656	47530	263	28412	5.8	60	92
24229	PORT/OR	2858	27879	226	19420	0.1	60	99
93819	INDIANA	3840	53047	265	30030	8.4	60	93
14942	OMAHA	3684	56036	308	32555	8.9	61	98
13739	PHILADE	4095	57509	287	32468	9.8	61	94
24127	SALTLA	3402	54317	345	32047	0.2	62	100
14732	NEWYOR	4122	53316	284	39581	6.9	62	93
24131	BOISE	3321	48363	339	24603	0.1	63	102
23234	SANFRA	3084	19160	361	34214	0.1	63	89
93814	CINCINN	4130	60169	273	31753	8.5	63	96
13983	COLUMBI	4287	62676	303	36300	9.6	63	95
13994	STLOUI	4212	67797	308	32549	11.7	64	97
93821	LOUISVI	4392	64124	307	33572	9.2	64	94
13988	KANSAS	4430	71148	326	39598	10.5	64	98
13985	DODGEC	4012	65109	353	46815	4.5	65	105
13743	WASHING	4429	69227	313	38863	8.7	65	100
13740	RICHMON	4417	64454	325	26928	13.8	65	96
24225	MEDFORD	3162	42995	325	19031	0.0	66	100
13737	NORFOLK	5068	70631	355	43847	14.2	68	95
23174	LOSANG	6027	46213	460	41370	2.9	68	96
23050	ALBUQUE	4267	66417	413	35628	1.4	68	97
23188	SANDIE	7013	59496	495	45272	3.3	69	90
13968	TULSA	4968	80292	373	46680	16.5	69	97
13897	NASHVIL	5046	76124	358	38870	14.9	69	93
13722	RALEIGH	4859	68950	357	33939	13.2	69	93
23047	AMARILL	4336	66725	403	54016	5.5	69	104
13967	OKLAHOM	4831	83038	357	66330	15.3	70	105
13874	ATLANTA	5415	74734	332	36496	17.6	70	93
13893	MEMPHIS	5338	89125	388	37352	19.1	71	101
23232	SACRAME	4088	57441	429	26454	0.5	72	104
13876	BIRMING	5620	83407	364	32895	18.3	72	93
23042	LUBBOCK	5050	82168	491	63167	8.5	73	100
13880	CHARLES	6030	94894	418	58206	22.1	74	94
12916	NEWORL	6422	109869	424	52366	26.8	74	94
3940	JACK/MS	5877	103303	413	44857	21.5	75	98
3927	FORTWO	5814	107495	409	48201	18.2	75	99
23044	ELPASO	5715	99071	509	46308	2.5	76	99
93193	FRESNO	4808	81872	491	29603	0.7	76	107
3937	LAKECH	6467	111224	419	45558	29.1	76	96
12918	HOUSTON	6626	115084	419	56110	28.1	76	96
12921	SANANT	6329	116764	426	53800	25.1	77	103
13889	JACK/FL	6925	116813	467	54352	25.1	78	95
12842	TAMPA	7920	136313	532	67761	33.3	80	95
12839	MIAMI	8527	168349	526	66256	44.0	82	91
12919	BROWNSV	7907	153162	522	87868	41.2	82	94
23183	PHOENIX	6284	136542	587	27451	6.0	84	111

TRY SITE COMMERCIAL CLIMATE INDICATORS
FOR COOLING DEGREE BASE 60
AND COOLING HUMIDITY RATIO BASE 0.01100

WBAN	TRY SITE	HOURS ABOVE BASE	DEGREE HOURS	INSOL ATION HOURS	WIND SPEED HOURS	HUMID RATIO HOURS	AVE DAILY MAX	ANN UAL MAX
24011	BISMARC	2264	30446	243	21857	1.5	51	102
14742	BURLING	2225	23411	177	18740	1.6	53	98
14922	MINNEAP	2866	38690	224	26167	4.3	53	97
14764	PORT/ME	2092	21376	208	16360	1.8	54	93
14733	BUFFALO	2617	25242	192	27076	1.6	55	89
14837	MADISON	2563	27302	202	22109	2.0	55	96
24143	GREATF	2115	24250	233	24375	0.0	55	93
14735	ALBANY	2684	28795	202	18357	4.0	56	92
14820	CLEVELA	2907	33067	228	23258	3.7	56	91
14739	BOSTON	2979	31486	227	36935	3.5	57	94
24233	SEATTLE	1458	12280	142	12170	0.0	57	98
24018	CHEYENE	2157	24185	256	21483	0.0	58	89
14819	CHICAGO	3120	34614	240	27922	2.8	58	99
94847	DETROIT	3125	34338	254	26580	4.6	58	93
94823	PITTSBU	3252	36960	246	25360	4.1	60	92
24229	PORT/OR	2178	19984	198	15368	0.0	60	99
93819	INDIANA	3389	41950	248	26442	6.4	60	93
14942	OMAHA	3313	45356	288	29432	6.9	61	98
13739	PHILADE	3667	45610	270	28863	7.6	61	94
24127	SALTLA	3048	44428	326	29132	0.1	62	100
14732	NEWYOR	3559	41492	253	33404	5.0	62	93
24131	BOISE	2882	38829	313	21560	0.0	63	102
23234	SANFRA	1851	11278	280	21767	0.0	63	89
93814	CINCINN	3763	48105	260	28694	6.2	63	96
13983	COLUMBI	3798	50272	282	31691	7.5	63	95
13994	STLOUI	3795	55557	292	29353	9.1	64	97
93821	LOUISVI	4018	51315	291	30620	6.7	64	94
13988	KANSAS	4016	58279	306	35722	8.1	64	98
13985	DODGEC	3672	53375	331	42993	2.7	65	105
13743	WASHING	4028	56307	296	35309	6.4	65	100
13740	RICHMON	3985	51604	308	24143	11.0	65	96
24225	MEDFORD	2638	34046	296	16582	0.0	66	100
13737	NORFOLK	4505	55922	334	38279	11.2	68	95
23174	LOSANG	4544	29625	408	32244	1.0	68	96
23050	ALBUQUE	3885	53989	386	32403	0.7	68	97
23188	SANDIE	5600	39827	445	37375	1.5	69	90
13968	TULSA	4484	65844	350	42243	13.3	69	97
13897	NASHVIL	4560	61464	339	35007	11.5	69	93
13722	RALEIGH	4341	54886	335	29789	10.3	69	93
23047	AMARILL	3928	54131	381	49129	3.6	69	104
13967	OKLAHOM	4373	68966	336	59700	12.3	70	105
13874	ATLANTA	4925	58952	313	32829	13.8	70	93
13893	MEMPHIS	4921	73524	369	34369	15.6	71	101
23232	SACRAME	3355	45963	397	22233	0.1	72	104
13876	BIRMING	5080	67081	345	30086	14.5	72	93
23042	LUBBOCK	4635	67429	465	57805	6.0	73	100
13880	CHARLES	5667	77183	405	55159	18.1	74	94
12916	NEWORL	5949	91094	407	47939	22.3	74	94
3940	JACK/MS	5506	86040	397	42212	17.4	75	98
3927	FORTWO	5448	90418	391	45204	14.5	75	99
23044	ELPASO	5307	82319	484	43203	1.2	76	99
93193	FRESNO	4284	67966	465	26624	0.2	76	107
3937	LAKECH	6042	92262	403	42460	24.3	76	96
12918	HOUSTON	6162	95627	404	52174	23.3	76	96
12921	SANANT	5955	98128	411	50893	20.5	77	103
13889	JACK/FL	6491	96459	450	51333	20.1	78	95
12842	TAMPA	7548	112873	522	64669	27.4	80	95
12839	MIAMI	8407	142889	522	65449	36.8	82	91
12919	BROWNSV	7595	129714	515	85074	35.0	82	94
23183	PHOENIX	5787	118195	564	25415	4.5	84	111

TRY SITE RESIDENTIAL CLIMATE INDICATORS
FOR HEATING DEGREE BASE 50
AND HEATING HUMIDITY RATIO BASE 0.00446

WBAN	TRY SITE	HOURS BELOW BASE	DEGREE HOURS	INSOL ATION HOURS	WIND SPEED HOURS	HUMID RATIO HOURS	AVE DAILY MIN	ANN UAL MIN
24011	BISMARC	5400	140854	143	46837	11.2	29	-34
14742	BURLING	4895	103181	121	38560	9.4	34	-19
24018	CHEYENE	4968	85108	160	56425	9.9	35	-17
14764	PORT/ME	5066	91708	154	34292	9.5	35	-11
24143	GREATF	4792	93142	122	71351	9.6	35	-23
14922	MINNEAP	4842	119232	141	43519	10.4	35	-30
14837	MADISON	4736	93316	117	36335	7.3	36	-18
14735	ALBANY	4608	90906	121	35892	8.2	37	-20
24127	SALTLA	4430	73569	126	33673	5.8	39	-4
14733	BUFFALO	4647	80871	117	49042	6.9	39	0
14942	OMAHA	4040	78412	115	33916	7.6	40	-17
24131	BOISE	4337	60959	112	30462	5.3	40	3
94847	DETROIT	4221	77871	107	39012	7.4	40	-8
24225	MEDFORD	3990	41113	77	11242	1.8	41	19
14820	CLEVELA	4292	76838	108	39867	8.0	41	0
14819	CHICAGO	4218	70643	117	35250	6.1	42	-8
94823	PITTSBU	4037	64036	102	35947	5.8	42	-6
93819	INDIANA	4010	70481	109	35882	5.8	42	-19
13985	DODGEC	3786	64228	116	40860	5.7	42	-8
24233	SEATTLE	4340	38346	78	36112	2.0	43	24
24229	PORT/OR	3964	37306	68	31736	2.1	44	22
14739	BOSTON	4005	61791	128	50430	7.0	44	7
23047	AMARILL	3283	45026	97	37779	4.6	44	3
13983	COLUMBI	3405	59872	93	31820	5.9	45	-11
13994	STLOUI	3588	59895	105	31200	4.7	45	-7
23050	ALBUQUE	3457	42807	147	24280	5.6	45	5
93814	CINCINN	3558	51763	98	31040	5.3	45	-5
13739	PHILADE	3755	56660	115	36579	7.0	45	11
13988	KANSAS	3397	58673	97	28171	5.8	46	-7
23042	LUBBOCK	2729	37329	90	33028	4.7	46	7
13740	RICHMON	3434	47326	108	23065	5.4	46	9
93821	LOUISVI	3369	47398	93	27011	4.5	47	-7
23232	SACRAME	2447	19599	52	10844	0.8	47	25
14732	NEWYOR	3373	42626	105	43012	5.3	48	9
13722	RALEIGH	2710	33427	88	19101	4.0	48	9
93193	FRESNO	2320	17406	39	11030	0.4	48	26
23234	SANFRA	1819	8188	29	11271	0.4	49	32
13967	OKLAHOM	2867	42036	89	40191	4.4	49	-1
13897	NASHVIL	2648	31995	76	21137	3.3	49	-1
13743	WASHING	3212	37035	94	26198	4.2	50	9
23044	ELPASO	2024	23158	64	11510	4.2	50	10
13968	TULSA	2583	35253	75	21099	3.0	50	0
13737	NORFOLK	2530	27100	81	24035	3.0	51	18
13876	BIRMING	2045	24382	56	10291	2.3	51	8
13893	MEMPHIS	2315	27816	74	16602	2.8	51	13
13874	ATLANTA	2237	23647	66	19567	2.7	52	14
3940	JACK/MS	1842	18847	52	12330	1.9	54	15
13880	CHARLES	1699	16280	42	14051	1.8	54	18
23174	LOSANG	329	1104	3	1524	0.1	55	37
3927	FORTWO	1868	17328	58	15949	2.1	55	19
23183	PHOENIX	1249	8920	14	4131	0.9	56	26
23188	SANDIE	260	791	4	674	0.2	57	38
12921	SANANT	1530	12506	35	13257	1.0	58	23
3937	LAKECH	1312	10591	28	10021	0.7	59	22
12918	HOUSTON	1153	9743	29	10677	1.0	60	20
13889	JACK/FL	771	5528	19	5583	0.6	60	27
12916	NEWORL	1229	9348	42	12739	1.2	60	25
12842	TAMPA	246	1179	3	1696	0.1	64	37
12919	BROWNSV	320	1589	5	3835	0.2	66	36
12839	MIAMI	62	338	2	486	0.0	70	36

TRY SITE RESIDENTIAL CLIMATE INDICATORS
FOR HEATING DEGREE BASE 55
AND HEATING HUMIDITY RATIO BASE 0.00446

WBAN	TRY SITE	HOURS BELOW BASE	DEGREE HOURS	INSOL ATION HOURS	WIND SPEED HOURS	HUMID RATIO HOURS	AVE DAILY MIN	ANN UAL MIN
24011	BISMARC	5898	169490	164	51176	11.3	29	-34
14742	BURLING	5657	129919	149	44706	9.6	34	-19
24018	CHEYENE	5681	112168	203	64080	10.6	35	-17
14764	PORT/ME	5803	119341	187	39015	9.7	35	-11
24143	GREATF	5629	119679	154	83241	10.2	35	-23
14922	MINNEAP	5236	144684	157	46905	10.4	35	-30
14837	MADISON	5419	119081	141	41729	7.4	36	-18
14735	ALBANY	5262	115885	144	40104	8.3	37	-20
24127	SALTLA	5025	97562	154	38806	5.9	39	-4
14733	BUFFALO	5246	105937	140	55131	7.1	39	0
14942	OMAHA	4690	100542	139	39438	7.8	40	-17
24131	BOISE	5000	84616	147	35522	5.7	40	3
94847	DETROIT	4859	100862	130	44033	7.5	40	-8
24225	MEDFORD	5033	64168	115	15711	2.0	41	19
14820	CLEVELA	4963	100291	133	45494	8.1	41	0
14819	CHICAGO	4849	93551	144	40565	6.2	42	-8
94823	PITTSBU	4712	86248	126	41710	5.9	42	-6
93819	INDIANA	4546	92081	129	40390	6.0	42	-19
13985	DODGEC	4430	85107	143	48022	5.9	42	-8
24233	SEATTLE	5894	64715	122	49631	2.1	43	24
24229	PORT/OR	5140	60484	103	39163	2.2	44	22
14739	BOSTON	4775	84334	160	60053	7.1	44	7
23047	AMARILL	3974	63531	129	45759	5.0	44	3
13983	COLUMBI	4000	78667	118	37510	6.1	45	-11
13994	STLOUI	4149	79491	129	36015	4.8	45	-7
23050	ALBUQUE	4102	62078	189	29293	6.5	45	5
93814	CINCINN	4241	71613	121	37557	5.5	45	-5
13739	PHILADE	4309	77116	135	41280	7.2	45	11
13988	KANSAS	3889	77165	119	32205	6.0	46	-7
23042	LUBBOCK	3288	52680	115	40332	5.1	46	7
13740	RICHMON	3990	66194	130	26254	5.5	46	9
93821	LOUISVI	3991	66161	115	32045	4.7	47	-7
23232	SACRAME	3781	35658	92	18659	0.8	47	25
14732	NEWYOR	4114	61815	134	51197	5.4	48	9
13722	RALEIGH	3416	49088	118	24166	4.3	48	9
93193	FRESNO	3377	32309	77	17190	0.4	48	26
23234	SANFRA	4076	23831	106	30653	0.5	49	32
13967	OKLAHOM	3538	58382	120	49620	4.7	49	-1
13897	NASHVIL	3301	47161	96	26232	3.5	49	-1
13743	WASHING	3924	55284	124	32515	4.5	50	9
23044	ELPASO	2651	35125	97	15841	5.1	50	10
13968	TULSA	3336	50583	103	27629	3.1	50	0
13737	NORFOLK	3191	41914	109	29866	3.2	51	18
13876	BIRMING	2707	36584	80	13344	2.5	51	8
13893	MEMPHIS	2978	41431	102	21561	3.0	51	13
13874	ATLANTA	2891	36814	90	24559	2.9	52	14
3940	JACK/MS	2491	29926	77	17169	2.1	54	15
13880	CHARLES	2318	26632	62	19237	1.9	54	18
23174	LOSANG	1319	5300	19	6919	0.3	55	37
3927	FORTWO	2539	28669	88	21496	2.4	55	19
23183	PHOENIX	1985	17251	35	7017	1.3	56	26
23188	SANDIE	948	4002	15	3191	0.5	57	38
12921	SANANT	2039	21614	53	17522	1.2	58	23
3937	LAKECH	1870	18809	44	13868	0.8	59	22
12918	HOUSTON	1764	17397	44	15729	1.1	60	20
13889	JACK/FL	1372	11047	37	9986	0.7	60	27
12916	NEWORL	1895	17474	65	18725	1.3	60	25
12842	TAMPA	557	3209	9	4231	0.1	64	37
12919	BROWNSV	639	4063	10	6639	0.3	66	36
12839	MIAMI	154	898	4	1086	0.0	70	36

TRY SITE RESIDENTIAL CLIMATE INDICATORS
FOR HEATING DEGREE BASE 60
AND HEATING HUMIDITY RATIO BASE 0.00446

WBAN	TRY SITE	HOURS BELOW BASE	DEGREE HOURS	INSOL ATION HOURS	WIND SPEED HOURS	HUMID RATIO HOURS	AVE DAILY MIN	ANN UAL MIN
24011	BISMARC	6412	200511	190	55314	11.4	29	-34
14742	BURLING	6377	160399	179	50566	9.7	34	-19
24018	CHEYENE	6448	142942	253	71651	11.1	35	-17
14764	PORT/ME	6514	150612	226	43946	9.8	35	-11
24143	GREATF	6449	150404	190	93863	10.6	35	-23
14922	MINNEAP	5776	172532	183	51456	10.4	35	-30
14837	MADISON	6076	148152	167	46510	7.5	36	-18
14735	ALBANY	5910	144170	176	44551	8.3	37	-20
24127	SALTLA	5574	124358	183	43263	6.1	39	-4
14733	BUFFALO	5972	134359	167	61804	7.1	39	0
14942	OMAHA	5324	125931	169	44869	8.0	40	-17
24131	BOISE	5736	111791	186	40698	6.0	40	3
94847	DETROIT	5471	127121	162	48993	7.6	40	-8
24225	MEDFORD	5952	92176	158	19867	2.1	41	19
14820	CLEVELA	5700	127277	162	51316	8.1	41	0
14819	CHICAGO	5490	119751	173	45887	6.3	42	-8
94823	PITTSBU	5372	111770	152	46882	6.0	42	-6
93819	INDIANA	5199	116756	154	45554	6.0	42	-19
13985	DODGEC	4951	108854	175	53804	6.1	42	-8
24233	SEATTLE	7114	98067	176	59707	2.1	43	24
24229	PORT/OR	6350	89931	148	46379	2.2	44	22
14739	BOSTON	5578	110404	200	69708	7.2	44	7
23047	AMARILL	4703	85628	167	54575	5.3	44	3
13983	COLUMBI	4770	101047	149	45001	6.2	45	-11
13994	STLOUI	4807	102236	158	41370	4.9	45	-7
23050	ALBUQUE	4741	84552	233	34508	7.1	45	5
93814	CINCINN	4857	94706	142	43129	5.6	45	-5
13739	PHILADE	4928	100462	162	46374	7.3	45	11
13988	KANSAS	4599	98780	148	38524	6.1	46	-7
23042	LUBBOCK	3986	71228	152	49249	5.4	46	7
13740	RICHMON	4612	87963	156	30157	5.7	46	9
93821	LOUISVI	4617	88001	139	37007	4.7	47	-7
23232	SACRAME	5178	59001	144	26808	0.9	47	25
14732	NEWYOR	5001	85043	175	60654	5.5	48	9
13722	RALEIGH	4243	68624	151	30421	4.5	48	9
93193	FRESNO	4292	52066	121	22759	0.4	48	26
23234	SANFRA	6566	52045	232	54916	0.6	49	32
13967	OKLAHOM	4218	78063	153	59077	4.9	49	-1
13897	NASHVIL	4031	65746	126	32275	3.6	49	-1
13743	WASHING	4573	76856	151	38259	4.6	50	9
23044	ELPASO	3301	50375	133	20676	5.9	50	10
13968	TULSA	4106	69541	135	34425	3.2	50	0
13737	NORFOLK	4014	60384	141	37797	3.3	51	18
13876	BIRMING	3495	52342	108	17476	2.6	51	8
13893	MEMPHIS	3693	58528	131	26795	3.1	51	13
13874	ATLANTA	3654	53575	119	30365	3.0	52	14
3940	JACK/MS	3127	44338	103	21991	2.2	54	15
13880	CHARLES	2979	40228	87	24800	2.0	54	18
23174	LOSANG	3719	18992	83	21605	0.5	55	37
3927	FORTWO	3186	43403	118	26772	2.6	55	19
23183	PHOENIX	2806	29692	65	10467	1.6	56	26
23188	SANDIE	2674	13265	63	11951	0.6	57	38
12921	SANANT	2663	33717	75	22503	1.2	58	23
3937	LAKECH	2583	30300	68	18944	0.9	59	22
12918	HOUSTON	2420	28116	67	21366	1.2	60	20
13889	JACK/FL	2127	20178	64	15426	0.8	60	27
12916	NEWORL	2661	29264	91	25906	1.4	60	25
12842	TAMPA	1060	7446	22	8486	0.2	64	37
12919	BROWNSV	1039	8374	18	10298	0.3	66	36
12839	MIAMI	312	2089	10	2156	0.0	70	36

TRY SITE RESIDENTIAL CLIMATE INDICATORS
FOR COOLING DEGREE BASE 60
AND COOLING HUMIDITY RATIO BASE 0.01027

WBAN	TRY SITE	HOURS ABOVE BASE	DEGREE HOURS	INSOL ATION HOURS	WIND SPEED HOURS	HUMID RATIO HOURS	AVE DAILY MAX	ANN UAL MAX
24011	BISMARC	2264	30446	243	21857	2.2	51	102
14742	BURLING	2225	23411	177	18740	2.4	53	98
14922	MINNEAP	2866	38690	224	26167	5.6	53	97
14764	PORT/ME	2092	21376	208	16360	2.4	54	93
14733	BUFFALO	2617	25242	192	27076	2.4	55	89
14837	MADISON	2563	27302	202	22109	2.9	55	96
24143	GREATF	2115	24250	233	24375	0.0	55	93
14735	ALBANY	2684	28795	202	18357	5.2	56	92
14820	CLEVELA	2907	33067	228	23258	5.0	56	91
14739	BOSTON	2979	31486	227	36935	4.7	57	94
24233	SEATTLE	1458	12280	142	12170	0.1	57	98
24018	CHEYENE	2157	24185	256	21483	0.0	58	89
14819	CHICAGO	3120	34614	240	27922	3.9	58	99
94847	DETROIT	3125	34338	254	26580	5.8	58	93
94823	PITTSBU	3252	36960	246	25360	5.4	60	92
24229	PORT/OR	2178	19984	198	15368	0.1	60	99
93819	INDIANA	3389	41950	248	26442	8.0	60	93
14942	OMAHA	3313	45356	288	29432	8.4	61	98
13739	PHILADE	3667	45610	270	28863	9.3	61	94
24127	SALTLA	3048	44428	326	29132	0.2	62	100
14732	NEWYOR	3559	41492	253	33404	6.4	62	93
24131	BOISE	2882	38829	313	21560	0.0	63	102
23234	SANFRA	1851	11278	280	21767	0.1	63	89
93814	CINCINN	3763	48105	260	28694	8.0	63	96
13983	COLUMBI	3798	50272	282	31691	9.1	63	95
13994	STLOUI	3795	55557	292	29353	11.1	64	97
93821	LOUISVI	4018	51315	291	30620	8.6	64	94
13988	KANSAS	4016	58279	306	35722	9.9	64	98
13985	DODGEC	3672	53375	331	42993	4.1	65	105
13743	WASHING	4028	56307	296	35309	8.2	65	100
13740	RICHMON	3985	51604	308	24143	13.2	65	96
24225	MEDFORD	2638	34046	296	16582	0.0	66	100
13737	NORFOLK	4505	55922	334	38279	13.5	68	95
23174	LOSANG	4544	29625	408	32244	2.4	68	96
23050	ALBUQUE	3885	53989	386	32403	1.2	68	97
23188	SANDIE	5600	39827	445	37375	2.9	69	90
13968	TULSA	4484	65844	350	42243	15.8	69	97
13897	NASHVIL	4560	61464	339	35007	14.1	69	93
13722	RALEIGH	4341	54886	335	29789	12.6	69	93
23047	AMARILL	3928	54131	381	49129	5.1	69	104
13967	OKLAHOM	4373	68966	336	59700	14.7	70	105
13874	ATLANTA	4925	58952	313	32829	16.7	70	93
13893	MEMPHIS	4921	73524	369	34369	18.3	71	101
23232	SACRAME	3355	45963	397	22233	0.4	72	104
13876	BIRMING	5080	67081	345	30086	17.4	72	93
23042	LUBBOCK	4635	67429	465	57805	7.9	73	100
13880	CHARLES	5667	77183	405	55159	21.2	74	94
12916	NEWORL	5949	91094	407	47939	25.8	74	94
3940	JACK/MS	5506	86040	397	42212	20.6	75	98
3927	FORTWO	5448	90418	391	45204	17.4	75	99
23044	ELPASO	5307	82319	484	43203	2.2	76	99
93193	FRESNO	4284	67966	465	26624	0.5	76	107
3937	LAKECH	6042	92262	403	42460	28.0	76	96
12918	HOUSTON	6162	95627	404	52174	27.1	76	96
12921	SANANT	5955	98128	411	50893	24.1	77	103
13889	JACK/FL	6491	96459	450	51333	23.9	78	95
12842	TAMPA	7548	112873	522	64669	32.0	80	95
12839	MIAMI	8407	142889	522	65449	42.4	82	91
12919	BROWNSV	7595	129714	515	85074	39.8	82	94
23183	PHOENIX	5787	118195	564	25415	5.7	84	111

TRY SITE RESIDENTIAL CLIMATE INDICATORS
FOR COOLING DEGREE BASE 65
AND COOLING HUMIDITY RATIO BASE 0.01027

WBAN	TRY SITE	HOURS ABOVE BASE	DEGREE HOURS	INSOL ATION HOURS	WIND SPEED HOURS	HUMID RATIO HOURS	AVE DAILY MAX	ANN UAL MAX
24011	BISMARC	1744	20078	211	17424	1.9	51	102
14742	BURLING	1556	13663	146	13497	2.1	53	98
14922	MINNEAP	2359	25397	199	21806	5.4	53	97
14764	PORT/ME	1472	12113	170	12388	2.1	54	93
14733	BUFFALO	1811	13734	155	19607	2.2	55	89
14837	MADISON	1821	15911	162	16324	2.7	55	96
24143	GREATF	1509	14851	190	17248	0.0	55	93
14735	ALBANY	2022	16742	166	14004	4.8	56	92
14820	CLEVELA	2219	19875	194	18028	4.8	56	91
14739	BOSTON	2100	18260	178	26372	4.4	57	94
24233	SEATTLE	778	6482	91	6552	0.0	57	98
24018	CHEYENE	1529	14702	211	15437	0.0	58	89
14819	CHICAGO	2267	20776	199	20504	3.7	58	99
94847	DETROIT	2244	20638	204	19153	5.6	58	93
94823	PITTSBU	2477	22290	215	19876	5.0	60	92
24229	PORT/OR	1295	11100	148	9853	0.1	60	99
93819	INDIANA	2741	26320	220	21352	7.7	60	93
14942	OMAHA	2712	30030	258	24386	8.3	61	98
13739	PHILADE	2969	28562	233	23312	9.1	61	94
24127	SALTLA	2415	30367	296	23750	0.1	62	100
14732	NEWYOR	2755	25186	216	25375	6.3	62	93
24131	BOISE	2164	25933	259	16503	0.0	63	102
23234	SANFRA	769	4357	141	8863	0.1	63	89
93814	CINCINN	3044	30613	235	23260	7.6	63	96
13983	COLUMBI	3000	32692	244	24945	8.9	63	95
13994	STLOUI	3224	37734	265	25075	10.7	64	97
93821	LOUISVI	3219	32811	255	24507	8.4	64	94
13988	KANSAS	3316	39554	267	29855	9.8	64	98
13985	DODGEC	2895	36568	291	34694	3.7	65	105
13743	WASHING	3296	37589	263	28612	7.9	65	100
13740	RICHMON	3291	33141	276	19923	12.8	65	96
24225	MEDFORD	1941	22354	242	13011	0.0	66	100
13737	NORFOLK	3567	35080	291	29299	13.1	68	95
23174	LOSANG	2201	11774	288	17468	1.6	68	96
23050	ALBUQUE	3115	35970	337	25967	0.9	68	97
23188	SANDIE	3296	16270	316	23285	2.8	69	90
13968	TULSA	3784	44884	316	35893	15.4	69	97
13897	NASHVIL	3784	40176	305	28759	13.5	69	93
13722	RALEIGH	3584	34607	299	24170	12.2	69	93
23047	AMARILL	3091	36187	333	39621	4.6	69	104
13967	OKLAHOM	3662	48523	301	49331	14.3	70	105
13874	ATLANTA	3956	36104	276	26056	15.9	70	93
13893	MEMPHIS	4161	50320	337	28797	17.9	71	101
23232	SACRAME	2444	31104	341	17191	0.3	72	104
13876	BIRMING	4172	43423	311	24945	16.7	72	93
23042	LUBBOCK	3798	45710	420	47346	7.0	73	100
13880	CHARLES	4787	50498	374	47040	20.6	74	94
12916	NEWORL	5120	63072	371	40549	25.5	74	94
3940	JACK/MS	4808	59888	369	36381	20.3	75	98
3927	FORTWO	4713	64543	361	39358	17.2	75	99
23044	ELPASO	4503	57280	435	37236	2.2	76	99
93193	FRESNO	3396	48356	413	21574	0.5	76	107
3937	LAKECH	5272	63642	374	36917	27.6	76	96
12918	HOUSTON	5411	66243	372	45602	26.6	76	96
12921	SANANT	5271	69687	380	45108	23.6	77	103
13889	JACK/FL	5527	65719	416	44743	23.3	78	95
12842	TAMPA	6555	76663	491	56394	31.3	80	95
12839	MIAMI	8036	101462	509	62837	42.2	82	91
12919	BROWNSV	6900	93055	496	78851	39.4	82	94
23183	PHOENIX	5054	90743	522	22339	5.7	84	111

TRY SITE RESIDENTIAL CLIMATE INDICATORS
FOR COOLING DEGREE BASE 70
AND COOLING HUMIDITY RATIO BASE 0.01027

WBAN	TRY SITE	HOURS ABOVE BASE	DEGREE HOURS	INSOL ATION HOURS	WIND SPEED HOURS	HUMID RATIO HOURS	AVE DAILY MAX	ANN UAL MAX
24011	BISMARC	1229	12410	169	12794	1.5	51	102
14742	BURLING	997	6958	108	8935	1.5	53	98
14922	MINNEAP	1666	14721	165	16144	4.4	53	97
14764	PORT/ME	864	5909	122	8076	1.4	54	93
14733	BUFFALO	1072	6140	112	12328	1.6	55	89
14837	MADISON	1071	8330	114	9957	2.0	55	96
24143	GREATF	987	8331	140	11342	0.0	55	93
14735	ALBANY	1235	8228	125	9129	3.5	56	92
14820	CLEVELA	1430	10356	153	12147	3.9	56	91
14739	BOSTON	1297	9452	122	16666	3.6	57	94
24233	SEATTLE	457	3348	60	3895	0.0	57	98
24018	CHEYENE	1037	7979	159	10715	0.0	58	89
14819	CHICAGO	1448	11027	153	13445	2.9	58	99
94847	DETROIT	1402	11056	152	12237	4.7	58	93
94823	PITTSBU	1606	11507	169	13633	3.5	60	92
24229	PORT/OR	748	5816	97	6032	0.0	60	99
93819	INDIANA	1878	14271	179	15051	6.4	60	93
14942	OMAHA	1994	17755	218	18466	7.4	61	98
13739	PHILADE	2131	15295	187	16693	7.9	61	94
24127	SALTLA	1826	19445	263	18498	0.1	62	100
14732	NEWYOR	1903	12871	176	17922	5.1	62	93
24131	BOISE	1550	16412	207	11999	0.0	63	102
23234	SANFRA	285	1659	56	3106	0.0	63	89
93814	CINCINN	2158	17129	199	16838	6.1	63	96
13983	COLUMBI	2195	19257	201	18166	7.9	63	95
13994	STLOUI	2447	23120	226	19528	9.4	64	97
93821	LOUISVI	2331	18444	210	18056	7.3	64	94
13988	KANSAS	2498	24577	217	23241	9.0	64	98
13985	DODGEC	2152	23604	247	26633	2.9	65	105
13743	WASHING	2496	22729	225	21720	7.0	65	100
13740	RICHMON	2381	18479	230	14892	10.8	65	96
24225	MEDFORD	1393	13825	187	9997	0.0	66	100
13737	NORFOLK	2542	19297	241	20206	11.3	68	95
23174	LOSANG	894	3627	164	7611	0.8	68	96
23050	ALBUQUE	2249	22097	280	19004	0.4	68	97
23188	SANDIE	1138	4291	176	9307	1.4	69	90
13968	TULSA	2982	27441	275	28729	13.9	69	97
13897	NASHVIL	2811	22893	265	21657	11.3	69	93
13722	RALEIGH	2457	18800	253	16840	9.8	69	93
23047	AMARILL	2223	22564	280	29533	3.4	69	104
13967	OKLAHOM	2931	31654	261	38692	13.0	70	105
13874	ATLANTA	2598	18665	231	16992	11.9	70	93
13893	MEMPHIS	3251	31407	293	22206	16.3	71	101
23232	SACRAME	1743	20332	273	12427	0.2	72	104
13876	BIRMING	3080	24478	274	19269	14.1	72	93
23042	LUBBOCK	2804	28689	366	35539	5.1	73	100
13880	CHARLES	3682	28867	325	36688	18.5	74	94
12916	NEWORL	4360	38933	336	34056	24.3	74	94
3940	JACK/MS	3895	37735	330	28683	18.6	75	98
3927	FORTWO	3919	42427	326	32477	16.1	75	99
23044	ELPASO	3539	36624	379	29966	1.9	76	99
93193	FRESNO	2610	32948	351	16986	0.5	76	107
3937	LAKECH	4270	39179	330	28345	25.5	76	96
12918	HOUSTON	4426	41165	329	35867	24.9	76	96
12921	SANANT	4283	45088	341	36773	21.0	77	103
13889	JACK/FL	4554	40054	378	37498	21.6	78	95
12842	TAMPA	5274	46351	447	45631	28.6	80	95
12839	MIAMI	7118	62733	488	57204	40.3	82	91
12919	BROWNSV	5987	60232	472	70105	37.5	82	94
23183	PHOENIX	4198	67138	468	18846	5.3	84	111

TRY SITE MOBILE HOME CLIMATE INDICATORS
FOR HEATING DEGREE BASE 56
AND HEATING HUMIDITY RATIO BASE 0.00435

WBAN	TRY SITE	HOURS BELOW BASE	DEGREE HOURS	INSOLATION HOURS	WIND SPEED HOURS	HUMID RATIO HOURS	AVE DAILY MIN	ANNUAL MIN
24011	BISMARC	5997	175487	170	51920	10.8	29	-34
14742	BURLING	5818	135737	156	46126	9.2	34	-19
24018	CHEYENE	5859	118027	214	65898	10.2	35	-17
14764	PORT/ME	5968	125309	195	40127	9.3	35	-11
24143	GREATF	5828	125507	163	85953	9.8	35	-23
14922	MINNEAP	5346	150030	162	47923	9.9	35	-30
14837	MADISON	5551	124632	145	42643	7.0	36	-18
14735	ALBANY	5394	121279	150	41026	7.9	37	-20
24127	SALTLA	5148	102710	160	39826	5.6	39	-4
14733	BUFFALO	5398	111335	146	56500	6.7	39	0
14942	OMAHA	4834	105376	145	40744	7.5	40	-17
24131	BOISE	5144	89760	154	36554	5.3	40	3
94847	DETROIT	5012	105874	137	45245	7.1	40	-8
24225	MEDFORD	5252	69420	123	16657	1.8	41	19
14820	CLEVELA	5107	105398	138	46719	7.7	41	0
14819	CHICAGO	4989	98540	149	41749	5.8	42	-8
94823	PITTSBU	4835	91083	131	42751	5.6	42	-6
93819	INDIANA	4668	96749	133	41306	5.6	42	-19
13985	DODGEC	4550	89657	149	49300	5.6	42	-8
24233	SEATTLE	6189	70904	132	52070	1.9	43	24
24229	PORT/OR	5415	65899	112	40870	2.0	44	22
14739	BOSTON	4889	89223	166	61488	6.8	44	7
23047	AMARILL	4136	67667	136	47753	4.7	44	3
13983	COLUMBI	4190	82857	124	39372	5.8	45	-11
13994	STLOUI	4284	83775	135	37250	4.5	45	-7
23050	ALBUQUE	4258	66336	199	30619	6.2	45	5
93814	CINCINN	4381	75994	125	38932	5.2	45	-5
13739	PHILADE	4416	81532	140	42191	6.9	45	11
13988	KANSAS	4024	81189	124	33295	5.7	46	-7
23042	LUBBOCK	3433	56113	122	42179	4.9	46	7
13740	RICHMON	4110	70304	136	27008	5.3	46	9
93821	LOUISVI	4122	70283	119	33016	4.4	47	-7
23232	SACRAME	4124	39782	102	20596	0.8	47	25
14732	NEWYOR	4311	66126	143	53377	5.1	48	9
13722	RALEIGH	3587	52675	124	25356	4.1	48	9
93193	FRESNO	3598	35907	87	18592	0.4	48	26
23234	SANFRA	4645	28476	128	35955	0.5	49	32
13967	OKLAHOM	3676	62058	126	51632	4.5	49	-1
13897	NASHVIL	3417	50578	101	27115	3.3	49	-1
13743	WASHING	4039	59323	130	33565	4.2	50	9
23044	ELPASO	2797	37922	105	16893	5.0	50	10
13968	TULSA	3496	54079	110	28989	2.9	50	0
13737	NORFOLK	3374	45288	117	31591	3.0	51	18
13876	BIRMING	2843	39427	85	14137	2.4	51	8
13893	MEMPHIS	3133	44564	107	22677	2.8	51	13
13874	ATLANTA	3062	39876	97	25859	2.7	52	14
3940	JACK/MS	2637	32563	82	18329	1.9	54	15
13880	CHARLES	2449	29081	68	20328	1.8	54	18
23174	LOSANG	1758	7058	26	9367	0.3	55	37
3927	FORTWO	2708	31377	96	22861	2.3	55	19
23183	PHOENIX	2173	19424	40	7779	1.2	56	26
23188	SANDIE	1186	5188	20	4177	0.5	57	38
12921	SANANT	2168	23782	58	18618	1.1	58	23
3937	LAKECH	2009	20818	49	14840	0.7	59	22
12918	HOUSTON	1894	19291	49	16857	1.1	60	20
13889	JACK/FL	1533	12580	42	11170	0.7	60	27
12916	NEWORL	2078	19552	70	20412	1.2	60	25
12842	TAMPA	654	3863	11	4993	0.1	64	37
12919	BROWNSV	702	4765	11	7168	0.3	66	36
12839	MIAMI	170	1068	5	1199	0.0	70	36

TRY SITE MOBILE HOME CLIMATE INDICATORS
FOR HEATING DEGREE BASE 60
AND HEATING HUMIDITY RATIO BASE 0.00441

WBAN	TRY SITE	HOURS BELOW BASE	DEGREE HOURS	INSOL ATION HOURS	WIND SPEED HOURS	HUMID RATIO HOURS	AVE DAILY MIN	ANN UAL MIN
24011	BISMARC	6412	200511	190	55314	11.1	29	-34
14742	BURLING	6377	160399	179	50566	9.5	34	-19
24018	CHEYENE	6448	142942	253	71651	10.9	35	-17
14764	PORT/ME	6514	150612	226	43946	9.6	35	-11
24143	GREATF	6449	150404	190	93863	10.4	35	-23
14922	MINNEAP	5776	172532	183	51456	10.2	35	-30
14837	MADISON	6076	148152	167	46510	7.3	36	-18
14735	ALBANY	5910	144170	176	44551	8.1	37	-20
24127	SALTLA	5574	124358	183	43263	5.9	39	-4
14733	BUFFALO	5972	134359	167	61804	6.9	39	0
14942	OMAHA	5324	125931	169	44869	7.8	40	-17
24131	BOISE	5736	111791	186	40698	5.8	40	3
94847	DETROIT	5471	127121	162	48993	7.4	40	-8
24225	MEDFORD	5952	92176	158	19867	2.0	41	19
14820	CLEVELA	5700	127277	162	51316	7.9	41	0
14819	CHICAGO	5490	119751	173	45887	6.1	42	-8
94823	PITTSBU	5372	111770	152	46882	5.8	42	-6
93819	INDIANA	5199	116756	154	45554	5.8	42	-19
13985	DODGEC	4951	108854	175	53804	5.9	42	-8
24233	SEATTLE	7114	98067	176	59707	2.0	43	24
24229	PORT/OR	6350	89931	148	46379	2.1	44	22
14739	BOSTON	5578	110404	200	69708	7.0	44	7
23047	AMARILL	4703	85628	167	54575	5.2	44	3
13983	COLUMBI	4770	101047	149	45001	6.0	45	-11
13994	STLOUI	4807	102236	158	41370	4.8	45	-7
23050	ALBUQUE	4741	84552	233	34508	7.0	45	5
93814	CINCINN	4857	94706	142	43129	5.5	45	-5
13739	PHILADE	4928	100462	162	46374	7.2	45	11
13988	KANSAS	4599	98780	148	38524	5.9	46	-7
23042	LUBBOCK	3986	71228	152	49249	5.3	46	7
13740	RICHMON	4612	87963	156	30157	5.5	46	9
93821	LOUISVI	4617	88001	139	37007	4.6	47	-7
23232	SACRAME	5178	59001	144	26808	0.8	47	25
14732	NEWYOR	5001	85043	175	60654	5.4	48	9
13722	RALEIGH	4243	68624	151	30421	4.4	48	9
93193	FRESNO	4292	52066	121	22759	0.4	48	26
23234	SANFRA	6566	52045	232	54916	0.5	49	32
13967	OKLAHOM	4218	78063	153	59077	4.8	49	-1
13897	NASHVIL	4031	65746	126	32275	3.5	49	-1
13743	WASHING	4573	76856	151	38259	4.4	50	9
23044	ELPASO	3301	50375	133	20676	5.7	50	10
13968	TULSA	4106	69541	135	34425	3.1	50	0
13737	NORFOLK	4014	60384	141	37797	3.2	51	18
13876	BIRMING	3495	52342	108	17476	2.6	51	8
13893	MEMPHIS	3693	58528	131	26795	3.0	51	13
13874	ATLANTA	3654	53575	119	30365	3.0	52	14
3940	JACK/MS	3127	44338	103	21991	2.1	54	15
13880	CHARLES	2979	40228	87	24800	2.0	54	18
23174	LOSANG	3719	18992	83	21605	0.5	55	37
3927	FORTWO	3186	43403	118	26772	2.5	55	19
23183	PHOENIX	2806	29692	65	10467	1.5	56	26
23188	SANDIE	2674	13265	63	11951	0.6	57	38
12921	SANANT	2663	33717	75	22503	1.2	58	23
3937	LAKECH	2583	30300	68	18944	0.9	59	22
12918	HOUSTON	2420	28116	67	21366	1.2	60	20
13889	JACK/FL	2127	20178	64	15426	0.8	60	27
12916	NEWORL	2661	29264	91	25906	1.3	60	25
12842	TAMPA	1060	7446	22	8486	0.2	64	37
12919	BROWNSV	1039	8374	18	10298	0.3	66	36
12839	MIAMI	312	2089	10	2156	0.0	70	36

TRY SITE MOBILE HOME CLIMATE INDICATORS
FOR HEATING DEGREE BASE 64
AND HEATING HUMIDITY RATIO BASE 0.00445

WBAN	TRY SITE	HOURS BELOW BASE	DEGREE HOURS	INSOL ATION HOURS	WIND SPEED HOURS	HUMID RATIO HOURS	AVE DAILY MIN	ANN UAL MIN
24011	BISMARC	6777	227038	210	58444	11.4	29	-34
14742	BURLING	6945	187368	203	54962	9.7	34	-19
24018	CHEYENE	7000	170125	290	76950	11.3	35	-17
14764	PORT/ME	7023	178010	256	47310	9.9	35	-11
24143	GREATF	6998	177683	225	100592	10.8	35	-23
14922	MINNEAP	6209	196730	203	55009	10.4	35	-30
14837	MADISON	6621	173779	194	50711	7.5	36	-18
14735	ALBANY	6493	169315	206	48402	8.3	37	-20
24127	SALTLA	6069	147905	207	47573	6.1	39	-4
14733	BUFFALO	6622	159875	196	67808	7.1	39	0
14942	OMAHA	5811	148464	194	48928	8.0	40	-17
24131	BOISE	6330	136230	227	44923	6.1	40	3
94847	DETROIT	6218	150842	202	55414	7.6	40	-8
24225	MEDFORD	6561	117590	201	23019	2.1	41	19
14820	CLEVELA	6254	151500	189	55612	8.1	41	0
14819	CHICAGO	6196	143377	208	52095	6.2	42	-8
94823	PITTSBU	5994	134762	175	51542	6.0	42	-6
93819	INDIANA	5763	139049	174	49953	6.0	42	-19
13985	DODGEC	5547	130127	205	60257	6.2	42	-8
24233	SEATTLE	7753	128191	220	64950	2.1	43	24
24229	PORT/OR	7190	117517	188	51439	2.2	44	22
14739	BOSTON	6287	134487	238	78137	7.2	44	7
23047	AMARILL	5332	105999	202	61778	5.5	44	3
13983	COLUMBI	5385	121717	177	50336	6.2	45	-11
13994	STLOUI	5316	122801	180	45156	4.9	45	-7
23050	ALBUQUE	5293	104887	270	39281	7.6	45	5
93814	CINCINN	5388	115464	161	47209	5.6	45	-5
13739	PHILADE	5466	121602	189	50805	7.3	45	11
13988	KANSAS	5151	118559	177	43423	6.1	46	-7
23042	LUBBOCK	4565	88557	183	56622	5.7	46	7
13740	RICHMON	5200	107966	183	33803	5.7	46	9
93821	LOUISVI	5214	107910	165	41705	4.7	47	-7
23232	SACRAME	5963	81795	186	30912	0.9	47	25
14732	NEWYOR	5643	106736	209	67489	5.6	48	9
13722	RALEIGH	4857	87143	177	35118	4.6	48	9
93193	FRESNO	5030	71049	163	26943	0.4	48	26
23234	SANFRA	7606	81121	338	66418	0.6	49	32
13967	OKLAHOM	4827	96469	181	68016	5.0	49	-1
13897	NASHVIL	4649	83445	150	37009	3.7	49	-1
13743	WASHING	5167	96619	177	43770	4.6	50	9
23044	ELPASO	3898	65074	170	25171	6.5	50	10
13968	TULSA	4711	87546	165	39984	3.2	50	0
13737	NORFOLK	4762	78415	172	44609	3.3	51	18
13876	BIRMING	4199	68090	135	21486	2.7	51	8
13893	MEMPHIS	4246	74722	156	30856	3.1	51	13
13874	ATLANTA	4348	69964	147	35371	3.1	52	14
3940	JACK/MS	3671	58175	125	26291	2.2	54	15
13880	CHARLES	3606	53569	108	30502	2.1	54	18
23174	LOSANG	5694	38790	179	33824	0.6	55	37
3927	FORTWO	3715	57445	141	31047	2.6	55	19
23183	PHOENIX	3416	42477	98	12864	1.8	56	26
23188	SANDIE	4485	28533	149	22808	0.7	57	38
12921	SANANT	3187	45734	100	26900	1.3	58	23
3937	LAKECH	3202	42124	90	23438	0.9	59	22
12918	HOUSTON	3026	39358	90	26572	1.3	60	20
13889	JACK/FL	2775	30233	88	19850	0.8	60	27
12916	NEWORL	3325	41563	117	31907	1.4	60	25
12842	TAMPA	1660	13123	41	13528	0.2	64	37
12919	BROWNSV	1547	13816	32	14844	0.3	66	36
12839	MIAMI	539	3843	18	3739	0.0	70	36

TRY SITE MOBILE HOME CLIMATE INDICATORS
FOR COOLING DEGREE BASE 61
AND COOLING HUMIDITY RATIO BASE 0.00994

WBAN	TRY SITE	HOURS ABOVE BASE	DEGREE HOURS	INSOL ATION HOURS	WIND SPEED HOURS	HUMID RATIO HOURS	AVE DAILY MAX	ANN UAL MAX
24011	BISMARC	2179	28182	238	21175	2.4	51	102
14742	BURLING	2089	21186	173	17684	2.7	53	98
14922	MINNEAP	2766	35824	220	25316	6.2	53	97
14764	PORT/ME	1961	19284	198	15451	2.7	54	93
14733	BUFFALO	2458	22625	185	25632	2.8	55	89
14837	MADISON	2431	24739	197	21185	3.3	55	96
24143	GREATF	2002	22135	226	23021	0.0	55	93
14735	ALBANY	2538	26111	194	17391	5.7	56	92
14820	CLEVELA	2779	30160	223	22304	5.6	56	91
14739	BOSTON	2840	28507	220	35251	5.2	57	94
24233	SEATTLE	1293	10822	132	10802	0.1	57	98
24018	CHEYENE	2035	22028	248	20266	0.1	58	89
14819	CHICAGO	2963	31494	232	26620	4.4	58	99
94847	DETROIT	2938	31213	243	24946	6.4	58	93
94823	PITTSBU	3098	33708	241	24216	6.0	60	92
24229	PORT/OR	1952	17806	188	14037	0.1	60	99
93819	INDIANA	3251	38561	243	25368	8.7	60	93
14942	OMAHA	3177	42043	281	28358	9.1	61	98
13739	PHILADE	3534	41943	263	27760	10.1	61	94
24127	SALTLA	2943	41380	320	28203	0.2	62	100
14732	NEWYOR	3415	37933	246	32011	7.1	62	93
24131	BOISE	2727	35947	303	20456	0.1	63	102
23234	SANFRA	1585	9427	255	18760	0.1	63	89
93814	CINCINN	3644	44342	256	27781	8.8	63	96
13983	COLUMBI	3678	46474	276	30584	9.8	63	95
13994	STLOUI	3684	51762	287	28477	11.9	64	97
93821	LOUISVI	3861	47297	283	29328	9.5	64	94
13988	KANSAS	3881	54263	298	34521	10.8	64	98
13985	DODGEC	3514	49703	325	41259	4.7	65	105
13743	WASHING	3899	52279	291	34117	9.0	65	100
13740	RICHMON	3823	47619	300	23151	14.1	65	96
24225	MEDFORD	2478	31408	285	15691	0.1	66	100
13737	NORFOLK	4340	51417	328	36869	14.5	68	95
23174	LOSANG	4085	25081	382	29322	3.0	68	96
23050	ALBUQUE	3756	50104	377	31265	1.4	68	97
23188	SANDIE	5180	34227	430	35043	3.6	69	90
13968	TULSA	4327	61360	344	40842	16.8	69	97
13897	NASHVIL	4414	56904	334	33888	15.2	69	93
13722	RALEIGH	4213	50545	330	28783	13.5	69	93
23047	AMARILL	3737	50203	369	46848	5.7	69	104
13967	OKLAHOM	4238	64593	330	57817	15.6	70	105
13874	ATLANTA	4735	54027	305	31456	17.9	70	93
13893	MEMPHIS	4770	68603	362	33312	19.5	71	101
23232	SACRAME	3146	42608	386	21164	0.6	72	104
13876	BIRMING	4920	62001	338	29172	18.6	72	93
23042	LUBBOCK	4510	62794	459	56149	8.6	73	100
13880	CHARLES	5542	71516	400	53974	22.6	74	94
12916	NEWORL	5762	85145	399	46211	27.4	74	94
3940	JACK/MS	5371	80534	391	41008	22.0	75	98
3927	FORTWO	5310	84970	385	44045	18.7	75	99
23044	ELPASO	5157	77012	475	42060	2.7	76	99
93193	FRESNO	4113	63682	455	25687	0.8	76	107
3937	LAKECH	5901	86220	398	41407	29.7	76	96
12918	HOUSTON	6021	89465	399	50934	28.7	76	96
12921	SANANT	5808	92173	405	49654	25.6	77	103
13889	JACK/FL	6340	89968	445	50345	25.6	78	95
12842	TAMPA	7426	105325	517	63608	34.0	80	95
12839	MIAMI	8356	134482	520	65101	44.9	82	91
12919	BROWNSV	7452	122119	511	83799	42.0	82	94
23183	PHOENIX	5638	112408	558	24860	6.3	84	111

TRY SITE MOBILE HOME CLIMATE INDICATORS
FOR COOLING DEGREE BASE 66
AND COOLING HUMIDITY RATIO BASE 0.01000

WBAN	TRY SITE	HOURS ABOVE BASE	DEGREE HOURS	INSOL ATION HOURS	WIND SPEED HOURS	HUMID RATIO HOURS	AVE DAILY MAX	ANN UAL MAX
24011	BISMARC	1631	18334	203	16413	2.0	51	102
14742	BURLING	1452	12107	139	12586	2.2	53	98
14922	MINNEAP	2271	23038	196	21097	5.7	53	97
14764	PORT/ME	1359	10641	164	11664	2.2	54	93
14733	BUFFALO	1663	11923	146	18194	2.3	55	89
14837	MADISON	1668	14090	153	15055	2.8	55	96
24143	GREATF	1399	13342	180	15964	0.0	55	93
14735	ALBANY	1855	14720	157	13012	4.9	56	92
14820	CLEVELA	2065	17656	185	16848	5.0	56	91
14739	BOSTON	1916	16160	166	24135	4.6	57	94
24233	SEATTLE	691	5704	84	5803	0.1	57	98
24018	CHEYENE	1440	13173	203	14586	0.0	58	89
14819	CHICAGO	2105	18509	191	19249	3.9	58	99
94847	DETROIT	2069	18394	194	17649	5.9	58	93
94823	PITTSBU	2329	19813	208	18834	5.2	60	92
24229	PORT/OR	1156	9805	136	8911	0.1	60	99
93819	INDIANA	2600	23579	214	20371	8.0	60	93
14942	OMAHA	2594	27318	251	23488	8.6	61	98
13739	PHILADE	2805	25593	225	22001	9.4	61	94
24127	SALTLA	2299	27952	291	22709	0.1	62	100
14732	NEWYOR	2632	22431	211	24218	6.5	62	93
24131	BOISE	2021	23769	247	15423	0.1	63	102
23234	SANFRA	603	3588	114	6793	0.1	63	89
93814	CINCINN	2874	27569	229	22005	7.9	63	96
13983	COLUMBI	2853	29692	237	23704	9.2	63	95
13994	STLOUI	3087	34510	258	24100	11.1	64	97
93821	LOUISVI	3051	29592	249	23356	8.8	64	94
13988	KANSAS	3158	36238	257	28588	10.3	64	98
13985	DODGEC	2739	33673	282	32952	4.0	65	105
13743	WASHING	3125	34293	256	27086	8.3	65	100
13740	RICHMON	3113	29850	266	18976	13.1	65	96
24225	MEDFORD	1812	20413	230	12321	0.0	66	100
13737	NORFOLK	3369	31513	283	27391	13.5	68	95
23174	LOSANG	1860	9573	269	15270	1.7	68	96
23050	ALBUQUE	2945	32855	326	24810	1.0	68	97
23188	SANDIE	2814	12974	291	20487	3.0	69	90
13968	TULSA	3637	41100	308	34561	15.9	69	97
13897	NASHVIL	3631	36392	298	27522	13.9	69	93
13722	RALEIGH	3384	31023	292	22849	12.5	69	93
23047	AMARILL	2909	33096	323	37525	4.8	69	104
13967	OKLAHOM	3516	44861	294	47264	14.8	70	105
13874	ATLANTA	3754	32148	269	24670	16.0	70	93
13893	MEMPHIS	3969	46159	328	27343	18.5	71	101
23232	SACRAME	2290	28660	329	16292	0.4	72	104
13876	BIRMING	4004	39251	303	23946	17.1	72	93
23042	LUBBOCK	3594	41912	409	44964	7.2	73	100
13880	CHARLES	4547	45711	365	44834	21.3	74	94
12916	NEWORL	4975	57952	365	39279	26.5	74	94
3940	JACK/MS	4609	55080	362	34765	21.0	75	98
3927	FORTWO	4556	59830	355	38058	18.0	75	99
23044	ELPASO	4338	52777	427	36055	2.5	76	99
93193	FRESNO	3234	44960	402	20612	0.7	76	107
3937	LAKECH	5097	58370	366	35371	28.4	76	96
12918	HOUSTON	5225	60832	363	43760	27.6	76	96
12921	SANANT	5113	64416	373	43857	24.3	77	103
13889	JACK/FL	5326	60192	410	43166	24.3	78	95
12842	TAMPA	6295	70108	484	54117	32.3	80	95
12839	MIAMI	7916	93426	506	62108	43.9	82	91
12919	BROWNSV	6741	86155	492	77570	40.7	82	94
23183	PHOENIX	4896	85689	512	21703	6.0	84	111

TRY SITE MOBILE HOME CLIMATE INDICATORS
FOR COOLING DEGREE BASE 70
AND COOLING HUMIDITY RATIO BASE 0.01004

WBAN	TRY SITE	HOURS ABOVE BASE	DEGREE HOURS	INSOL ATION HOURS	WIND SPEED HOURS	HUMID RATIO HOURS	AVE DAILY MAX	ANN UAL MAX
24011	BISMARC	1229	12410	169	12794	1.6	51	102
14742	BURLING	997	6958	108	8935	1.7	53	98
14922	MINNEAP	1666	14721	165	16144	4.7	53	97
14764	PORT/ME	864	5909	122	8076	1.5	54	93
14733	BUFFALO	1072	6140	112	12328	1.7	55	89
14837	MADISON	1071	8330	114	9957	2.2	55	96
24143	GREATF	987	8331	140	11342	0.0	55	93
14735	ALBANY	1235	8228	125	9129	3.8	56	92
14820	CLEVELA	1430	10356	153	12147	4.2	56	91
14739	BOSTON	1297	9452	122	16666	3.9	57	94
24233	SEATTLE	457	3348	60	3895	0.0	57	98
24018	CHEYENE	1037	7979	159	10715	0.0	58	89
14819	CHICAGO	1448	11027	153	13445	3.2	58	99
94847	DETROIT	1402	11056	152	12237	4.9	58	93
94823	PITTSBU	1606	11507	169	13633	3.7	60	92
24229	PORT/OR	748	5916	97	6032	0.1	60	99
93819	INDIANA	1878	14271	179	15051	6.7	60	93
14942	OMAHA	1994	17755	218	18466	7.7	61	98
13739	PHILADE	2131	15295	187	16693	8.3	61	94
24127	SALTLA	1826	19445	263	18498	0.1	62	100
14732	NEWYOR	1903	12871	176	17922	5.4	62	93
24131	BOISE	1550	16412	207	11999	0.0	63	102
23234	SANFRA	285	1659	56	3106	0.0	63	89
93814	CINCINN	2158	17129	199	16838	6.5	63	96
13983	COLUMBI	2195	19257	201	18166	8.2	63	95
13994	STLOUI	2447	23120	226	19528	9.8	64	97
93821	LOUISVI	2331	18444	210	18056	7.8	64	94
13988	KANSAS	2498	24577	217	23241	9.5	64	98
13985	DODGEC	2152	23604	247	26633	3.2	65	105
13743	WASHING	2496	22729	225	21720	7.4	65	100
13740	RICHMON	2381	18479	230	14892	11.3	65	96
24225	MEDFORD	1393	13825	187	9997	0.0	66	100
13737	NORFOLK	2542	19297	241	20206	11.8	68	95
23174	LOSANG	894	3627	164	7611	1.0	68	96
23050	ALBUQUE	2249	22097	280	19004	0.5	68	97
23188	SANDIE	1138	4291	176	9307	1.6	69	90
13968	TULSA	2982	27441	275	28729	14.5	69	97
13897	NASHVIL	2811	22893	265	21657	11.9	69	93
13722	RALEIGH	2457	18800	253	16840	10.3	69	93
23047	AMARILL	2223	22564	280	29533	3.7	69	104
13967	OKLAHOM	2931	31654	261	38692	13.6	70	105
13874	ATLANTA	2598	18665	231	16992	12.5	70	93
13893	MEMPHIS	3251	31407	293	22206	16.9	71	101
23232	SACRAME	1743	20332	273	12427	0.3	72	104
13876	BIRMING	3080	24478	274	19269	14.7	72	93
23042	LUBBOCK	2804	28689	366	35539	5.5	73	100
13880	CHARLES	3682	28867	325	36688	19.3	74	94
12916	NEWORL	4360	38933	336	34056	25.3	74	94
3940	JACK/MS	3895	37735	330	28683	19.4	75	98
3927	FORTWO	3919	42427	326	32477	16.9	75	99
23044	ELPASO	3539	36624	379	29966	2.2	76	99
93193	FRESNO	2610	32948	351	16986	0.6	76	107
3937	LAKECH	4270	39179	330	28345	26.5	76	96
12918	HOUSTON	4426	41165	329	35867	25.8	76	96
12921	SANANT	4283	45088	341	36773	21.9	77	103
13889	JACK/FL	4554	40054	378	37498	22.6	78	95
12842	TAMPA	5274	46351	447	45631	29.7	80	95
12839	MIAMI	7118	62733	488	57204	41.8	82	91
12919	BROWNSV	5987	60232	472	70105	38.8	82	94
23183	PHOENIX	4198	67138	468	18846	5.7	84	111

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