PART TWO

CHAPTER 4: CHOOSING A METHODOLOGY

Overview

Each HA has the discretion to choose the method it wants to establish its utility allowances, so long as the method is consistent with the standards specified in 24 CFR Part 965. Which methodology is the most appropriate for a particular agency depends on the HA's particular characteristics and resources. This chapter provides guidance to HAs in choosing the most suitable methodology. The key component of this chapter is the ***Decision Tree***, which is found in Exhibit 4.1. The Decision Tree guides an HA through a series of questions about the following information:

- the utility functions for which an allowance is necessary
- the HA's assessment of the reasonableness of the current utility allowances
- the features of the HA's current allowance methodology
- the availability and quality of consumption data
- the ability of the HA to obtain data on heat loss and heating system efficiency, if relevant
- the occurrence of resident complaints or legal challenges.

Depending on the HA's answers to these questions, the Decision Tree will provide a recommendation regarding the most appropriate methodology.

Questions Posed in the Decision Tree

This section walks the reader through the central questions posed in the Decision Tree, explaining key concepts and providing guidance in answering the questions.

Does the HA feel that its current allowances are reasonable, based on the standards set by the federal regulations?

The reasonableness of allowances depends on several factors. Reasonable allowances meet the following conditions:

- the allowances include utilities that are checkmetered and/ or individually metered
- the allowances approximate the consumption of an "energy-conservative household"
- any amount over the consumption allowance that is established is within the ability of the resident to control

Exhibit 4.1
Decision Tree for Selecting a Utility Allowance Method

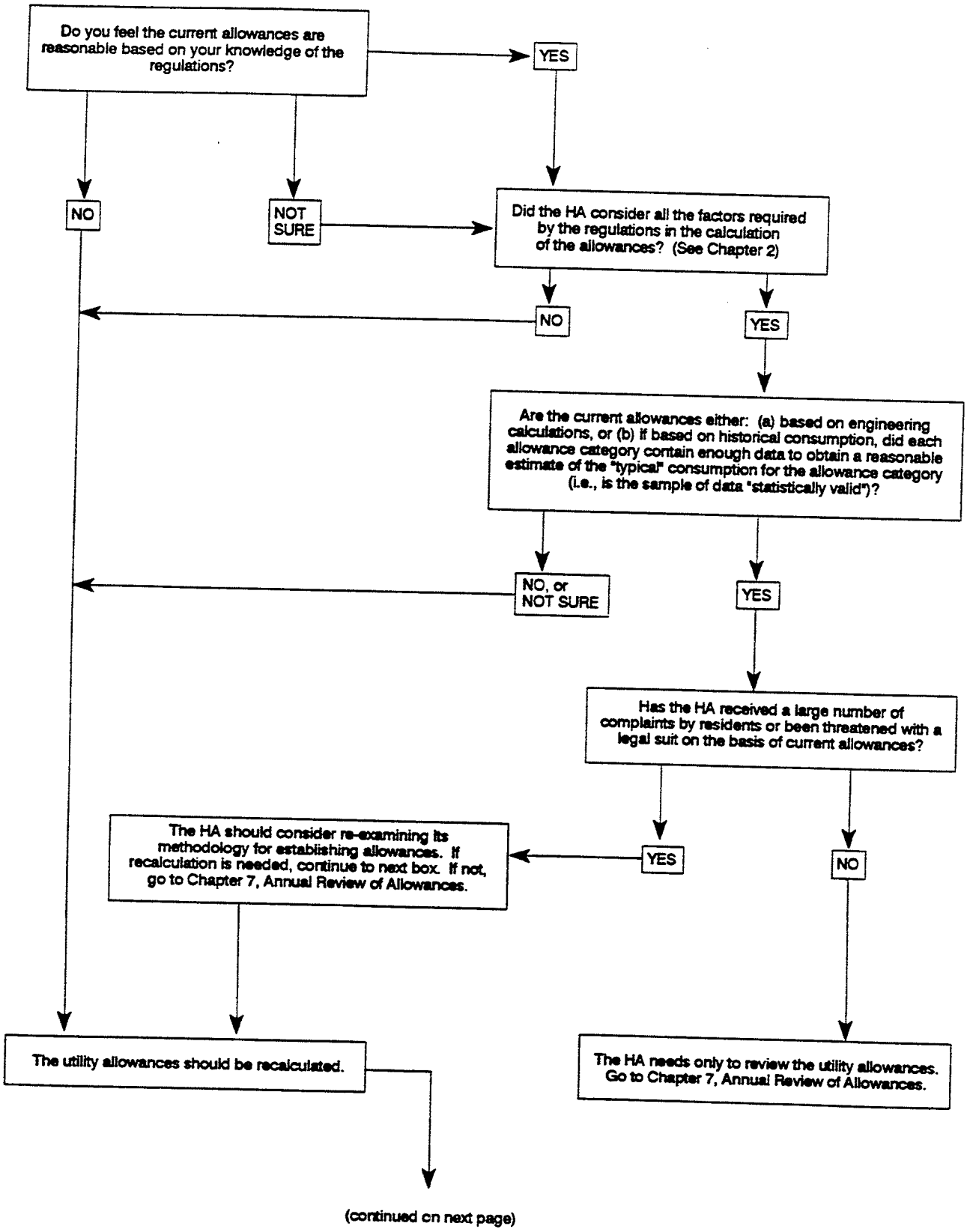

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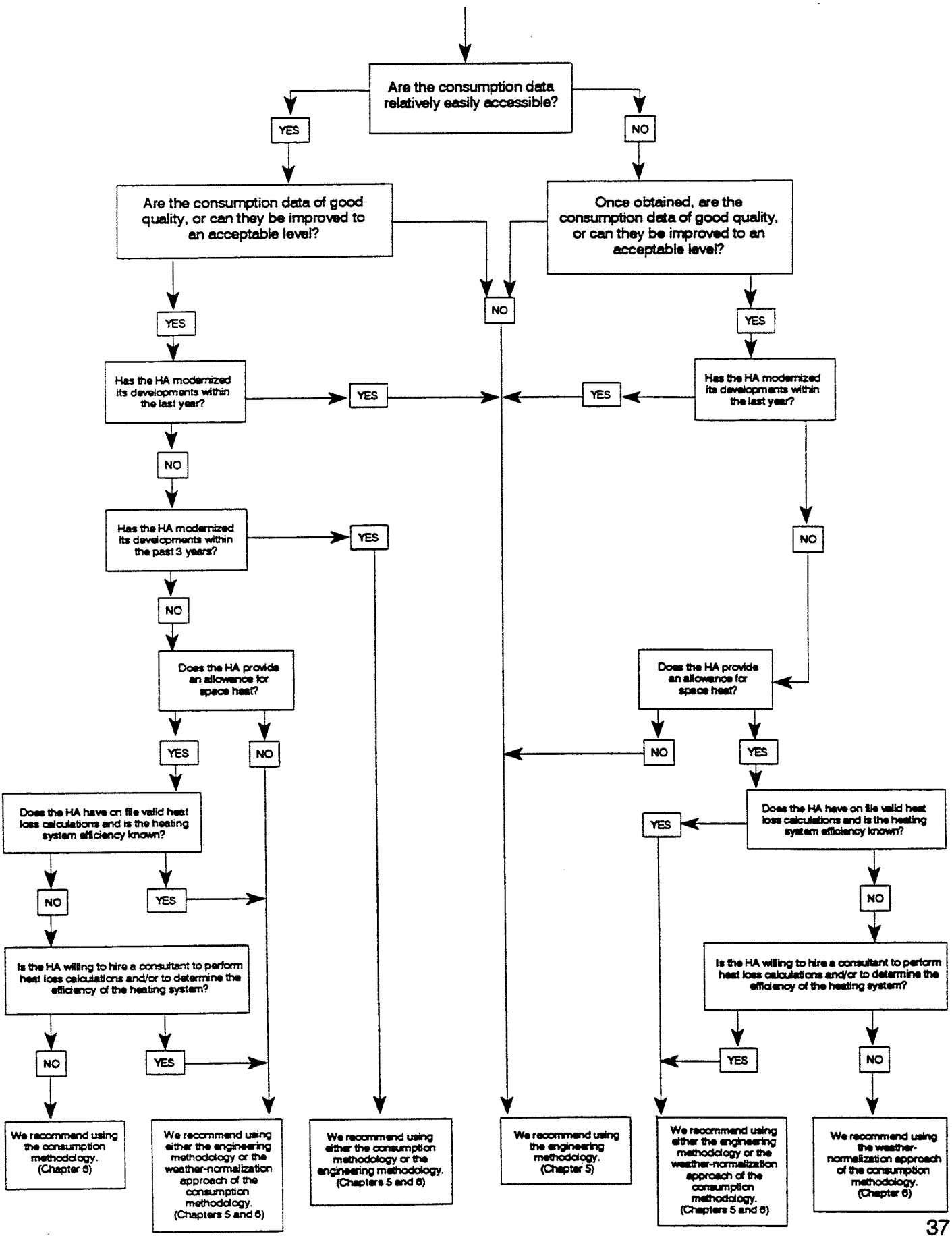
Exhibit 4.1 (cont.)
Decision Tree for Selecting a Utility Allowance Method



- the allowances take into account the factors outlined in the regulations
- the allowances are reviewed annually.

If one or more of these conditions is not met, then the allowances should not be considered reasonable.

Did the HA consider all the factors required by the regulations in the calculation of the allowances?

As explained in Chapter 2, the regulations require that the following factors be taken into account when establishing allowances:

- equipment and functions to be covered by the allowance
- climatic conditions
- dwelling unit size and number of occupants
- construction and design of the housing development
- energy efficiency of appliances and equipment
- physical condition of the development
- indoor temperature
- hot water temperature.

"Taking into account each factor" means considering each factor and determining whether it would make a substantial difference to the allowance. Factors that would make a significant difference to the allowance should be incorporated into the calculation of the allowance. How a factor is incorporated into the calculation depends on which methodology is being used.

With the ***consumption-based methodology***, incorporating a factor means using it as a criterion for forming ***allowance categories***. For example, if one development has a new, efficient heating system, and a neighboring development has an old, inefficient heating system, then the two developments should have separate allowance schedules for space heating.

With the ***engineering-based methodology***, a factor can be incorporated into the calculation of the allowance in one of two ways, depending on the factor and the end-use. First, it may be used as a criterion for forming allowance categories. Alternatively, it may be plugged into an equation to develop the figure for allowed usage. For example, the energy efficiency of heating equipment is an input to the formula used to determine energy requirements for space heating.

Are the current allowances either: (a) based on engineering calculations, or (b) if based on historical consumption, did each allowance category contain enough data to obtain a reasonable estimate of the "typical" consumption for the allowance category?[1]

Under the consumption-based methodology, in order to develop a reasonable idea of the "typical" consumption for an allowance category, there should be enough records (separate pieces of information or examples) in the data set to make the data set "statistically valid." Statistical validity is concerned with the level of certainty or confidence one can have that the data being examined truly reflect the actual phenomenon being studied. The number of records needed to make a data set statistically valid depends on how much variation there is among the data. The problems caused by variation in the data can often be reduced by including more data in the sample, such as when weather data from multiple years are used to offset year-by-year variation in weather patterns.

The concept of statistical validity is a complex one, but achieving such validity (within reasonable limits) is critical if the consumption methodology is being used. Chapter 6 provides guidelines about how to determine how much information is required for a statistically valid data set. As a rough rule of thumb, if an HA is unable to use a 100% sample for an allowance category, it should construct a sample that includes "clean" data from at least 20 randomly selected units for each allowance category (see Chapter 6 for details). If an HA does not think that it can achieve this standard for sample size, HA staff should carefully read Chapter 6 to determine whether the consumption methodology is actually appropriate for its use.

Has the HA received a large number of complaints by residents or been threatened with a legal suit on the basis of the current allowances?

If many residents have complained about the current allowances, or if the HA has been threatened with a legal suit, then it is particularly important for the HA to review carefully whether its method for calculating allowances is consistent with the regulations. Although complaints by residents do not necessarily mean that the allowances are unreasonable, it is suggested that the HA check whether its method and allowances are defensible; if there is some doubt about this, the HA should consider upgrading the method through use of the guidance in this guidebook.

[1] If HA staff are not sure of how the current allowances were calculated, this question should be answered "no."

Even if there have not been many formal complaints about the allowances, if a significant percentage of resident households are currently paying surcharges, it would also be advisable for the HA to review its allowances to determine the portion of these surcharges that are due to non-allowable uses as opposed to "excess consumption." If many surcharges are due to the latter, the HA needs to ensure that any consumption above the current allowance levels are within the ability of the residents to control.

Are the utility records relatively easily accessible, given HA staff resources?

When using the consumption methodology, where utilities are individually metered, the HA must obtain individual consumption records from the local utility. Typically, utilities will not release a record to an HA unless the resident whose name is on the account has signed a release form giving the utility permission to release the data. Some utilities are more willing than others to supply large quantities of consumption records.

Are the consumption data of good quality?

Good quality data must satisfy the following conditions:

- All consumption data should be adjusted for vacancy.
- Where utilities are individually metered, there should not be more than two months in a row of consumption data based on estimated reads.
- Where utilities are checkmetered, the consumption data should be from routine and regularly scheduled readings of properly calibrated checkmeters.

Can the quality of the consumption data be improved to an acceptable level?

Whether or not the quality of the data can be improved depends on the reason they are not of good quality in the first place:

- If the consumption data have not been adjusted for vacancy, then the data can be improved by making this adjustment or by removing units that have been vacant from the database. If the data are removed, then the HA must determine whether data from sufficient numbers of units remains to be able to achieve statistical validity.

- If utility records contain more than two months in a row of consumption data based on estimated reads, these records should be removed from the database. If, after removing the data based on estimated reads, enough data remain for the data sets to be statistically valid, then the consumption data may be acceptable.

- If checkmeter readings have not been made routinely and consistently, or the checkmeters were not properly calibrated during the period covered by the data, then the data cannot be improved to an acceptable level.

Has the HA modernized any developments during the past year?

If the HA has modernized any developments during the past year, then the pre-modernization consumption data for those developments will not accurately reflect the utility requirements of the dwelling units in those developments, and the HA will have less than one year's worth of post-modernization consumption data. Therefore, the engineering methodology should be used for those developments.

Has the HA modernized any developments within the past three years?

If the HA has modernized any developments within the past three years, then the pre-modernization consumption data for those developments will not accurately reflect the utility requirements of the dwelling units in those developments, and the HA will have less than three years' worth of post-modernization consumption data. Therefore, the three-year rolling base approach of the consumption methodology is inappropriate for those developments. The HA should use the engineering methodology, or alternatively, if an allowance is provided for space heat, the weather-normalization approach of the consumption methodology may be used.

If an allowance for space heat is provided, does the HA have on file (or have the capacity to secure a consultant to provide) valid heat loss calculations and heating efficiency ratings?

For the engineering-based method to be used to calculate allowances for space heat, accurate information on heat loss and heating efficiency for the HA's buildings is essential. Without such data on file, or the ability to hire consultants to provide this information, the consumption-based methodology is probably the most appropriate approach for the HA to use.

Based on the reader's responses to the questions posed in Exhibit 4.1, the Decision Tree will provide a recommended course of action to (a) maintain the HA's current methodology and conduct an annual review; (b)

recalculate the allowances using an improved version of the HA's current methodology; or (c) adopt a new methodology.

If you are using (or planning to use) the ***engineering methodology***, Chapter 5 provides additional guidance. If you are using the ***consumption methodology***, then Chapter 6 should be consulted.

CHAPTER 5: ESTABLISHING ALLOWANCES USING THE ENGINEERING METHODOLOGY

Overview

The engineering-based methodology is an approach that uses technical calculations of utility requirements, rather than historical consumption data on dwelling units, to set allowances. That is, the engineering approach focuses on ***what consumption ought to be for the dwelling unit***, rather than concentrating on what it actually has been. Under the engineering approach, the ***energy*** and ***water*** consumption requirements of a dwelling unit are estimated using engineering calculations, building-specific information, and standardized consumption tables. Consumption requirements (i.e., consumption allowances) are determined ***separately*** for each allowable end-use, such as space heating, domestic hot water (DHW), cooking, refrigeration, lighting, miscellaneous end-uses, and water.

This chapter is divided into two main sections. The first section describes each of the steps in the process of establishing allowances using the engineering-based methodology. The second section provides a series of examples that lead the reader through each step of the process.

The following process is used to establish allowances under the engineering-based methodology:

Step #1: Specify allowable and non-allowable end-uses to determine which end-uses should be included in the allowances.

Step #2: Create the allowance categories.

Steps #3-#12: Estimate the consumption requirements for each end-use for each allowance category. These steps determine consumption requirements in terms of consumption units, such as therms, ccf, kWh, or gallons. HAs that do not provide an allowance for a particular end-use should skip the step for that end-use and continue to the next one.

Step #13: Aggregate the consumption requirements from the component end-uses (from Steps 3-12) to obtain the consumption allowance for each utility (e.g., electricity or gas) for each allowance category.

It is a good idea to compare these with available consumption data, to see if the results are similar.

Step #14: Convert the consumption allowances from Step 13 into dollar allowances. At this point, HAs with individually metered utilities will convert the dollar allowances into equal monthly amounts (unless the local utility does not provide an equal payments plan and the HA provides seasonally adjusted allowances).

Step #15: Publish the allowances and provide an opportunity for the residents to comment.

Exhibit 5.1 provides a schematic representation of these steps.

Step #1: Specifying Allowable and Non-Allowable End-Uses

The first step in establishing allowances with the engineering-based methodology is to determine which end-uses are to be covered by the allowances—that is, which end-uses are considered allowable end-uses. Following are examples of end-uses that may be included in allowances:

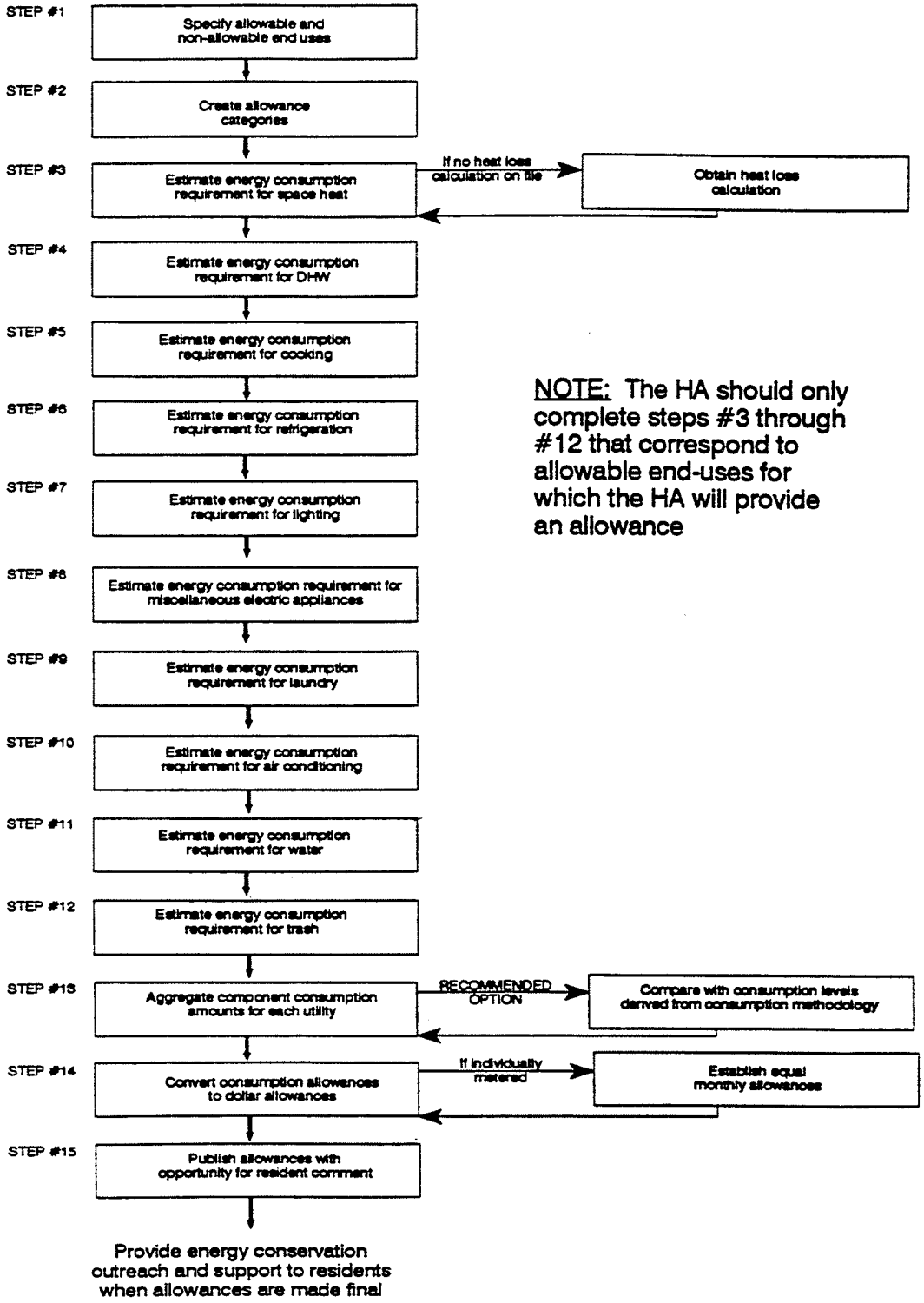
- space heating
- domestic hot water
- cooking
- refrigeration
- lighting
- miscellaneous electrical appliances
- laundry
- air conditioning
- water/sewer
- trash/garbage pickup.

In determining which end-uses should be included in the allowances, the HA should consider: (a) how the utility is metered, and (b) whether there are any end-uses that the HA specifically ***excludes*** from allowances.

As discussed in Chapter 2, an allowance should be provided for any utility that is checkmetered or individually metered, or for non-metered utilities that the residents pay for directly, such as trash/garbage pickup. Therefore, the allowances should include end-uses that are associated with those utilities.

End-uses that are specifically excluded from allowances are called ***non-allowable end-uses***. Some end-uses may be considered allowable end-uses by one HA but non-allowable by another HA. Even within one HA's

Exhibit 5.1
Steps in the Engineering-Based Methodology



NOTE: The HA should only complete steps #3 through #12 that correspond to allowable end-uses for which the HA will provide an allowance

portfolio, some end-uses may be considered allowable for some units, but non-allowable for others. Such decisions are left to the HA to make, based on local custom and usage as well as the local climate. *(Please refer to Chapter 2 for a discussion of air conditioning.)*

Step #2: Creating the Allowance Categories

Allowance categories are the groups of units for which the allowances are specified. As noted in Chapter 2, different allowance categories are necessary because different types of dwelling units have varying consumption requirements. Allowance categories should be distinguished by characteristics that significantly affect the consumption requirements of a household. These characteristics may include any of the following factors:

- equipment and functions to be covered by the allowance
- climatic conditions
- dwelling unit size
- number of occupants
- type of construction and design of the housing development
- energy efficiency of appliances and equipment
- physical condition of the development
- indoor temperature.
- hot water temperature

At a minimum, categories of allowances should be differentiated by ***equipment and functions*** covered by the allowance, ***dwelling unit size and number of occupants per dwelling unit***, and ***construction and design*** of the housing development. To differentiate allowance categories by equipment and functions covered by the allowance means to group together only units that have the same types of equipment and functions. For example, a unit with gas cooking should not be grouped with a unit that has electric cooking.

Further, where the ***energy efficiency of HA-supplied appliances and equipment*** varies significantly among developments, separate allowance categories should be developed. For example, developments with original furnaces or refrigerators should be considered separately from developments with new heating systems and new refrigerators.

Where the allowance covers space heating, the allowance categories should also take into account the ***physical condition*** of the housing development. In other words, two developments of the same construction and design but in different physical condition should not be grouped together in forming allowance categories. In addition, ***dwelling unit configuration or location within a building*** (for example, the number of

exterior walls the unit has, or whether the unit is on the top floor or bottom) and ***indoor temperature*** should also be criteria in developing the allowance categories where the allowance covers space heat. A heat loss calculation should take into account all of these factors. ***There should be a separate heat loss calculation for each allowance category.***

It is important to note that each factor may affect the consumption requirements of ***some*** end-uses but not others. Therefore, the number of allowance categories that are required will depend on which end-uses are covered by the allowances. An HA that provides allowances for electric end-uses that do not include space heating might have only a few allowance categories, distinguished by dwelling unit size and number of occupants, for each type of development. On the other hand, an HA that provides allowances for space heating will tend to need more allowance categories.

Step #3: Estimating the Energy Consumption Requirements for Space Heating

In public housing, space heat is generally provided by electricity or gas, and less frequently, by propane or oil. The space heating requirements of a dwelling unit depend on various factors, including dwelling unit size and configuration within the building, the construction and design of the housing development, the physical condition of the development, the local climate, the energy efficiency of the heating system, and the indoor temperature. These factors are taken into account in the following formula, which is used to determine annual energy requirements for space heating for a given dwelling unit type:

$$\text{Annual Energy Consumption} = \frac{\text{heat loss (in Btu/hr) x heating degree days x 24 hours/day}}{\text{system efficiency x Btu/fuel unit x design temperature differential}}$$

Much of the information required for this formula, such as the heating degree days and the Btu per fuel unit, is provided in this guidebook. Other information, such as the heat loss calculations and the system efficiency, are site-specific and must be obtained by the HA. In some cases, professional consultation may be required. The inputs to the formula are described below:

Annual Energy Consumption. The formula determines the annual space heating energy requirements in terms of appropriate fuel units (kWh, therms, ccf, or gallons).

Heat Loss. The heat loss, or design heat loss, is the rate of heat transfer, in Btus per hour, from occupied space to the outdoors. Losses occur through walls, ceilings and floors of a structure, and though cracks around windows, doors, etc. The heat loss depends

on the dwelling unit size and configuration within the building, the construction and design of the housing development, the physical condition of the development, amount of insulation in the walls and ceilings, the assumed indoor temperature, and various other factors. ***See section below on Obtaining Heat Loss Calculations.***

Heating Degree Days. Heating degree days are a measure of the severity of the winter in a given locality: the more degree days, the harsher the winters. Heating degree-days represent the difference between 65 degrees Fahrenheit (65°F) and the daily mean temperature when the latter is less than 65°F. Appendix C provides a list of the 30-year average heating degree days for various geographical areas throughout the country.

System Efficiency. The efficiency of the heating system depends on its type and age. Non-ducted electric heating systems have an efficiency of 100 percent. For other types of heating systems, the system efficiency generally ranges from 50 to 85 percent. Heating systems installed before 1975 generally have efficiencies of 70 percent or less. Systems installed from 1975 to present typically fall into the range of 75 to 85 percent. ***Note: The system efficiency is generally lower than the furnace or boiler efficiency because of distribution losses. If the HA is in a region where there are more than 2,500 heating degree days per year on average, it is especially important that the HA have an accurate estimate of the efficiency of the heating system for each allowance category.***

Btus per Fuel Unit. This factor is the heating value of the fuel used for space heat. The heating value of the fuel is plugged into the formula to convert Btus into other units, such as ccf or therms for gas, or kWh for electricity. The Btu per fuel unit conversion factors are as follows:

1 kWh	=	3,413	Btus
1 ccf natural gas[1]	=	100,000	Btus
1 therm natural gas	=	100,000	Btus
1 gallon No. 1 oil	=	134,950	Btus
1 gallon No. 2 oil	=	139,400	Btus
1 gallon No. 4 oil	=	145,600	Btus
1 gallon propane	=	91,600	Btus

[1] The actual Btus per ccf gas may vary. The local gas company can provide the Btu content of the gas in its service area. For the purposes of this guidebook, we assume 100,000 Btus per ccf gas.

Design Temperature Differential (Indoor Temperature - Outdoor Design Temperature in Winter). The design temperature differential, also called "Delta T" or the design range, is the difference between the presumed indoor temperature in winter and the outdoor design temperature in winter. The ***maximum*** indoor winter temperature in public housing is typically 72°F for family developments and 75°F for elderly developments. The actual indoor temperature may be lower. The outdoor design temperature is the lowest outdoor winter temperature that could occur in a given location, based on a certain confidence level. Appendix C provides the outdoor design temperatures for various localities in each state.

Obtaining Heat Loss Calculations

There are several ways to obtain heat loss calculations, and following is a list of options. The most appropriate option depends on the circumstances of the development. HAs in regions with 2,500 or more heating degree days per year are strongly encouraged to have a licensed professional engineer perform the heat loss calculations.

Note: There should be one heat loss calculation for each space heating allowance category. Allowance categories should take into account dwelling size and location within the building.

Option 1: **Check the files.** Many HAs have already had heat loss calculations done on dwelling units, often during an energy audit performed by the local utility or a consulting engineering firm. If the heat loss calculations have been performed within five years, and no major changes (for example, new heating equipment, windows, or insulation) have been made to the development since these calculations were performed, then they may be used to establish allowances. Otherwise, new heat loss calculations should be performed.

Option 2: **Have staff engineer perform heat loss calculation.** Some HAs may have a staff engineer who knows how to perform heat loss calculations.

Option 3: **Ask the local utility.** If there is no engineer on staff who knows how to perform heat loss calculations, the HA may be able to request that the local utility perform the heat loss calculations as part of an energy audit. The HA should be

prepared to provide the utility with architectural drawings of the buildings.

Option 4: **Hire a consultant or heating system service company.** If the local utility is not able to perform the heat loss calculations within a reasonable timeframe, then the HA may choose to hire an engineering consultant or heating system service company to perform the heat loss calculation. The HA should be prepared to provide the consultant or service company with architectural drawings of the buildings.

Once the HA has obtained a heat loss calculation for each allowance category and has gathered the other necessary information, it can calculate the annual energy requirement for space heating for each allowance category by using the formula shown on p. 47.

This formula yields the ***annual*** consumption requirement for space heating. The next step is to determine the ***monthly*** requirement for space heating. The monthly space heating requirements are determined through the following process. *(**Note: Monthly requirements should <u>not</u> be determined by simply dividing the annual consumption requirement by 12 months, because the energy requirement for space heating is concentrated in the winter months and is generally non-existent in the summer months, and because many utilities charge rates that vary seasonally.**)*

To calculate monthly space heating allowances:

1) **Find the 30-year average heating degree days *for each month*.** The 30-year average heating degree days for each of the 12 months are provided in Appendix C of this guidebook.

2) **Find the 30-year average *annual* heating degree days.** The 30-year average annual heating degree days are provided in Appendix C of this guidebook. ***Note: The sum of the 30-year average heating degree days for the 12 months is equal to the 30-year average annual heating degree days.***

3) **For each month, divide the 30-year average heating degree days *for that month* (from #1) by the *annual* 30-year average heating degree days (from #2).** These calculations will yield the percent of annual heating demand for each month.

4) **For each month, multiply the percentage obtained in #3 by the annual consumption requirement for space heating.** These calculations will yield the monthly space heating consumption requirements.

Step #4: Estimating the Energy Consumption Requirements for Domestic Hot Water

Domestic hot water is heated using natural gas, electricity, propane, or oil. The monthly energy requirements for domestic hot water are calculated using a formula that determines the amount of energy it takes to heat a certain number of gallons to a certain temperature. The formula is as follows:

$$\text{Monthly Energy Consumption} = \frac{\text{temperature rise (in degrees) x 8.33 lb/gal x gal/month/unit}}{\text{system efficiency x Btu/fuel unit}}$$

The inputs to the formula are described below:

Temperature Rise. The temperature rise is the difference between the cold water temperature and the hot water temperature. The cold water temperature depends on the geographical location and tends to vary seasonally. Most water utilities can provide the average temperature of the water in their service area. Alternatively, the following average temperatures (in degrees Fahrenheit) may be used:

Northern localities:	40 degrees
North Central localities:	50 degrees
Central localities:	60 degrees
Southern localities:	70 degrees

(Note: these temperatures are consistent with HUD's Life Cycle Cost Analysis Handbook, 7418.1 CHG-1. These temperatures are average temperatures—actual cold water temperatures may vary substantially from season to season.)

The hot water temperature at the tap may range from 115°F to 140°F. The suggested temperature for hot water at the tap in public housing is 120°F.

8.33 Pounds/Gallon. There are 8.33 pounds per gallon of water. This figure is a constant used to convert the units from gallons to pounds, to be consistent with Btus.

Gallons/month/unit. The number of gallons of hot water per unit per month depends on the number of people per unit and on whether the dwellings have water-saving devices such as low-flow

showerheads or faucet aerators. In addition, the presence of certain water-using appliances affects hot water requirements. On average, a person requires roughly 20 gallons of hot water per day if the unit has low-flow faucets and aerators. Gallons per month per unit are calculated by multiplying the gallons per person per day by the number of persons in the household times 31 days. For example, if each person in a two-person household is allowed 20 gallons per day, the gallons per month per unit would be 20 gallons x 2 people x 31 days, which equals 1,240 gallons. ***Note: Actual hot water usage may vary widely depending on the age and lifestyle of the residents. If the units are not equipped with water-saving devices, or if there are hot water leaks in some of the apartments, hot water requirements may be higher. In addition, if laundry is deemed an allowable end-use, 20 gallons per person per day may not be sufficient to cover reasonable hot water usage. A conventional washer uses about 30-50 gallons per load,[2] so if a household does just one load of hot-water laundry (or two loads of warm-water laundry) per person per week, then the per-person hot water requirement increases to 25 gallons per day.***

System Efficiency. The efficiency of the hot water heating system depends on the fuel type, and on the age and type of the system. Electric water heaters have an efficiency of 100 percent, and the efficiency of gas water heaters is typically in the range of 50 to 60 percent, with newer water heaters tending to have higher efficiency ratings. However, especially in cases where the water heating system has a lengthy distribution system or a separate storage tank, the *system* efficiency is lower than that of the water heater itself because of storage and distribution heat losses, and the temperature at the tap is lower than the temperature at the hot water heater. In such cases, it is advised that a licensed professional engineer estimate the efficiency of the system.

Btu Per Fuel Unit. This factor is the heating value of the fuel used for water heating. The heating value of the fuel is plugged into the formula to convert Btus into other units, such as ccf or therms for gas, or kWh for electricity. The Btu per fuel unit conversion factors were listed in Step #3, above.

[2] Per *Home Water Conservation Guide,* Massachusetts Water Authority, 1989.

Note: Tables 5.1 through 5.5 in this chapter assume an occupancy of two people per bedroom. A 0-bedroom unit is assumed to have one person. HAs with different occupancy patterns should adjust the consumption amounts accordingly. It is important to note that in public housing for the elderly, 1-bedroom units generally have only one occupant. In this case, the consumption amounts listed for 0-bedroom may be more appropriate.

Step #5: Estimating the Energy Consumption Requirements for Cooking

Cooking is powered by electricity, gas, or propane. Energy requirements for cooking depend on household size. Table 5.1 provides monthly consumption amounts generally considered reasonable for HAs. Actual consumption requirements vary according to the energy efficiency of the appliance and the amount it is used, which is a function of household size.

Table 5.1. Suggested Monthly Energy Consumption Requirements for Cooking[a]

	0 BR	1 BR	2 BR	3 BR	4 BR	5 BR
Electric (kWh)	47 kWh	52 kWh	62 kWh	71 kWh	77 kWh	84 kWh
Gas (therms)	4.8 thm	5.4 thm	6.5 thm	7.4 thm	8.1 thm	8.8 thm
Propane (gal)	5.2 gal	5.9 gal	7.1 gal	8.1 gal	8.8 gal	9.6 gal

[a] The gas consumption levels shown in this table are found in HUD's Lifecycle Cost Analysis Handbook. The electric consumption level for the 0-bedroom dwelling unit was derived using standard consumption tables from various utilities; the electric consumption levels for all other dwelling units were derived using the percent differential among usage for dwelling units as found in the Handbook. The propane consumption levels were derived from the gas amounts, assuming 91,600 Btus per gallon propane.

Step #6: Estimating the Energy Consumption Requirements for Refrigeration

Energy consumption of refrigerators can vary from about 500 kWh per year to over 2,000 kWh per year, depending on the age, size, and type of the refrigerator. Because of this high level of variation, it is important that HAs use information specific to particular buildings or developments. If there is significant variation of refrigerator efficiency within a given development, the allowance should take this fact into account. The monthly requirement for refrigeration is the annual energy consumption divided by 12 months.

Step #7: Estimating the Energy Consumption Requirements for Lighting

The energy requirements for lighting depend on the number and wattage of the light bulbs in a dwelling unit and on the number of hours the lights are on. Generally, the larger the household, the more light bulbs there are in the dwelling unit and the more hours the lights are on. The HA must make assumptions about how many light bulbs there are in each dwelling unit type and how many hours are considered reasonable consumption for households of various sizes. The lighting requirements can be determined as follows:

1) For each room in the dwelling unit (e.g., living room, kitchen, pantry, hall, bathroom and bedrooms and porch), add together the wattage of the light bulbs to obtain the total ***Watts for each room.***

2) Multiply the Watts for each room (from #1) by the number of hours the lights are on per day in that particular room to get ***daily Watt-hours for each room.***

3) Add together the daily Watt-hours for each room (from #2) to get ***daily Watt-hours for the dwelling unit.***

4) Divide the daily Watt-hours for the dwelling unit (from #3) by 1000 to convert the Watt-hours into ***daily kiloWatt-hours (kWh) for the dwelling unit.***

5) Multiply the daily kWh for the dwelling unit (from #4) by 31 days to determine ***monthly kWh for the dwelling unit.***

Energy consumption requirements for lighting in public housing typically fall into the ranges indicated in Table 5.2.

Table 5.2. Monthly Electric Consumption Requirements for Lighting, Typical Ranges[a]

	0-1 Bedroom	2 Bedrooms	3 Bedrooms	4+ Bedrooms
Range	70-90 kWh	90-135 kWh	105-185 kWh	120-235 kWh

[a] These ranges are based on consumption levels that various HAs, HUD field offices, and national consulting firms have used to calculate allowances.

Step #8: Estimating the Energy Consumption Requirements for Miscellaneous Electric Appliances

Miscellaneous appliances include various tenant-owned electric appliances used by an energy-conservative household of modest means. Examples of electrical appliances that may fall into this category are clocks, televisions, radios, toasters, microwave ovens, blenders, coffee makers, irons, vacuum cleaners, and fans.

The energy consumption requirements of small electrical appliances vary depending on the energy efficiency of the appliances and on how many hours they are used every day. Because these are tenant-owned appliances, it would be impractical to determine these factors. Instead, the HA can make assumptions about the appliances being used in the dwelling units and use standard consumption tables available from the local utility to estimate reasonable consumption levels. A sample of such a table, from the Edison Electric Institute, is included in Appendix C. The energy requirement for miscellaneous electric appliances increases with household size—a good rule of thumb is an increase of about 20 to 30 percent for each additional bedroom.

Energy consumption requirements of miscellaneous electric appliances in public housing typically fall into the ranges indicated in Table 5.3.

Table 5.3. Monthly Electric Consumption Requirements of Miscellaneous Appliances, Typical Ranges[a]

	0-1 Bedroom	2 Bedrooms	3 Bedrooms	4+ Bedrooms
Range	50-135 kWh	65-170 kWh	80-205 kWh	100-240 kWh

[a] As was the case in Table 5.2, these ranges are based on consumption levels that various HAs, HUD field offices, and national consulting firms have used to calculate allowances.

Many HAs find that providing an allowance for "miscellaneous" electrical items can be a fair and practical alternative to listing all the items covered by the allowance.

Step #9: Estimating the Energy Consumption Requirements for Laundry

Where clothes washer and/or clothes dryer hook-ups are provided by the HA, an allowance may be provided for the energy used by those appliances. HAs that do not provide an allowance for clothes washers or dryers should skip this section and continue to Step #10.

Clothes Washers. The electricity consumption requirement of a clothes washer depends on the wattage of the clothes washer, the

number of loads per dwelling unit per month, and the length of an average wash cycle.

$$\text{Monthly Electricity Requirement} = \frac{\text{Watts x loads/month x length of load (in hours)}}{1000}$$

Table 5.4 provides monthly electric consumption requirements of a typical clothes washer, assuming eight half-hour (0.5 hr) loads per person per month and two persons per bedroom. ***Note: These assumptions may vary from HA to HA.***

Table 5.4. Monthly Electric Consumption Requirements of a Typical Clothes Washer

	0 BR	1 BR	2 BR	3 BR	4 BR	5 BR
Clothes washer (600 W)	2.5 kWh	5 kWh	10 kWh	15 kWh	20 kWh	25 kWh

Clothes Dryers. The energy (gas or electricity) consumption requirement of a clothes dryer depends on the wattage or gas usage of the dryer, the number of loads per dwelling unit per month, and the length of an average drying time.

A typical electric clothes dryer is 5000 Watts.[3] A typical gas clothes dryer uses about 0.22 therms per hour.[4] Assuming eight 45-minute loads per person per month and two persons per bedroom, the consumption requirements for typical clothes dryers are described in Table 5.5. ***Note: These assumptions may vary from HA to HA.***

[3] Based on standard consumption tables from Edison Electric Institute (1994), Philadelphia Electric Company (1990), and Pacific Gas & Electric Company (1993).

[4] Based on standard consumption tables from Pacific Gas & Electric Company (1993) and the U.S. Department of Energy (Test and Evaluation Branch, Conservation and Renewable Energy).

Table 5.5. Monthly Energy Consumption Requirements of Typical Clothes Dryers

	0 BR	1 BR	2 BR	3 BR	4 BR	5 BR
Electric dryer (5000 W)	30 kWh	60 kWh	120 kWh	180 kWh	240 kWh	300 kWh
Gas dryer (.22 therms/hr)	1.5 thms	3 thms	6 thms	8 thms	11 thms	13 thms

Step #10: Estimating the Energy Consumption Requirements for Air Conditioning

Some HAs provide an allowance for air conditioning. (Refer to Chapter 2 for a discussion of air conditioning.) HAs that do not provide an allowance for air conditioning should skip this section.

Where an allowance is provided for air conditioning, the air conditioning unit is typically a room unit air conditioner. The monthly energy consumption requirements of a room air conditioner depend on the wattage of the air conditioner and on the number of hours per day it is used. As with miscellaneous electrical appliances, this information is often impractical to obtain, therefore, the HA must make assumptions about the wattage and use of the air conditioners. The number of hours per day that air conditioning is needed depends on the regional climate and local custom and usage.

The monthly energy consumption requirements of an air conditioner may be estimated with the following formula:

$$\text{Monthly Electrical Consumption} = \frac{\text{Watts x hours in use/day x 31 days/month}}{1000}$$

Table 5.6 provides the monthly consumption amounts for typical air conditioners using various usage assumptions. According to the Edison Electric Institute table in Appendix C, the average room air conditioner is 670 Watts. The average energy-efficient air conditioner is 500 Watts.

Table 5.6. Monthly Electric Consumption Requirements for Typical Air Conditioners (kWh)

	3 hours/day	6 hours/day
Energy-efficient (500 Watts)	47 kWh	93 kWh
Average efficiency (670 Watts)	62 kWh	125 kWh

Step #11: Estimating the Consumption Requirements for Water

The level of water consumption that is reasonable depends on the number of occupants in a dwelling unit and on whether the dwelling unit has low-volume toilets, faucet aerators, and low-flow showerheads. For units where these water-saving measures have been installed, 60 gallons per person per day can generally be considered a reasonable amount. (This amount is consistent with literature from several utilities. The 60 gallons includes water used for laundry.) If these water-saving measures are not in place, the allowable amount should be higher. In addition, where outdoor watering by residents is permitted, the allowance should account for this additional usage. The per-person per-day amount must then be multiplied by the number of legal occupants in the unit and by 31 days to get a per-unit per-month figure.

Many water utilities charge per hundred cubic feet (ccf) rather than per gallon. In such cases, the HA should covert the consumption amount estimated in this step from galions to ccf before changing the consumption allowance into a dollar allowance. Gallons are converted to ccf using the following conversion factor:

1 gallon = .001337 ccf

Checking for Leaks or Meter Calibration Problems

Before calculating the allowance for water, the HA should check the consumption on the master meter and compare it to the total consumption measured by the checkmeters. If these two amounts differ by more than 2 percent, the following steps should be taken:

Step 1: Check the calibration of the checkmeters. *Where water is checkmetered, examine 3 or 4 percent of the checkmeters for calibration problems. This sample size should provide a good indication of whether the checkmeters are calibrated properly.*

Step 2: Check the distribution and service lines. *Check the distribution lines on the street and the service lines on the property. Check the valve between the distribution line and the service line.*

Step 3: Check for leaks in the apartments. *Distribute a notice to residents asking them to notify the HA of any leaks from faucets, showers, tubs, toilets, or garden hoses.*

Step #12: Estimating the Consumption Requirements for Trash/Garbage

Where trash/garbage pickup is not metered but is charged as a flat rate, this flat rate should be the amount of the trash allowance. Where trash/ garbage pickup is metered according to the volume of trash (typically in terms of number of 30-gallon cans), then one trash can per household per week is generally sufficient.

HAs should schedule several times during the year when residents may exceed the trash allowance to accommodate greater disposal needs due to certain circumstances, such as residents moving in or out, spring cleaning, and the holidays. HAs are advised to take measures to ensure that the trash services are used solely by the public housing community.

Reducing Trash Pickup Costs Through Recycling

In many areas of the country, HAs that pay private haulers for trash/garbage pickup services can reduce the cost of trash pickup by up to one-third by starting a recycling program in the housing developments. The markets for recyclable goods such as paper (which includes newspaper, paper bags, and junk mail), glass, aluminum and other metals, and plastics are growing stronger in many regions. For this reason, recyclable goods can often be hauled away at a much lower cost than generic trash. In many regions, the recycling company will pay for the materials on a per-ton basis. Check local listings for recycling companies in your area.

Step #13: Aggregating Component Consumption Amounts for Each Utility

The monthly consumption requirements of various end-uses, such as space heating, hot water, cooking, lighting, etc, have now been determined for each allowance category. The next step is to establish a ***total consumption allowance for each utility*** (e.g., gas, electricity) within each allowance category, by adding the component consumption amounts for that utility. For example, if space heating, cooking, and hot water are all provided by gas, then the consumption amounts for space heating, hot water and cooking should be aggregated to get a total gas consumption allowance.

This process of adding up all the component allowances of each utility must be completed for each allowance category.

Step #14: Converting Consumption Allowances to Dollar Allowances

For each allowance category, each of the 12 monthly consumption amounts must be converted into a dollar amount.

Electricity. Consumption amounts of electricity are in kWh. The kWh amounts are converted to dollar amounts by multiplying the kWh by the utility rate, which is the price per kWh, and adding the base charge or consumer charge and any other charges levied by the utility. Some utilities charge one rate for usage up to a certain level and another rate for usage beyond this level. If the local utility has seasonal rates, the HA should multiply the consumption amounts by the rate appropriate to that particular season or even the particular month. For example, if the utility has one rate for September through May, and another rate for June through August, then the consumption amounts in June, July, and August should be multiplied by the summer rate, and the

consumption amounts in the other months should be multiplied by the off-season rate. In some cases, the utility also levies a demand charge for part or all of the year.

Gas. Consumption amounts for gas are in ccf or therms. The consumption amounts for gas in terms of ccf or therms are converted to dollar amounts by multiplying them by the price per ccf or therm and adding any customer charges or adjustments. As with electricity, if the gas company has seasonal rates, these rates should be used for the appropriate months.

Water. The consumption amounts for water in terms of gallons or ccf are converted to dollar amounts by multiplying them by the price per ccf or gallon. Frequently, this per-volume charge varies according to the amount of water used. In most areas, there is an additional charge for sewer service, which may be a flat fee or a per-volume amount. If the sewer charge is a rate charged per ccf or gallon, then this fee should be multiplied by the ccf or gallons, and added to the dollar amount for water. Where the sewer rates vary seasonally, the rate appropriate for each month should be used. Where water is individually metered, if a monthly flat fee is charged, this amount should be added to the dollar allowance.

Propane or Oil. Consumption amounts for propane and oil are in gallons. The consumption amounts for propane or oil in terms of gallons are converted to dollar amounts by multiplying the consumption amounts by the average price per gallon of propane or oil.

HAs with individually metered utilities generally provide equal monthly allowances for those utilities. (However, if the utility supplier does not offer residents a uniform payment plan, the HA may provide for seasonal variations in its allowances.) Where equal monthly allowances are provided, the monthly dollar allowances for each allowance category should be added together to get an annual dollar amount for each allowance category. This amount should then be divided by 12 to get equal monthly allowances.

Recommended Option: Comparing Engineering Calculations to Actual Consumption

If at all possible, it is a good idea to check the consumption allowances developed using the engineering-based methodology against actual consumption records. This process provides insight into how actual consumption compares to "reasonable consumption" as determined using the engineering-based methodology. It is particularly important if the HA is switching to the engineering-based methodology from another one.

Moreover, when using the engineering methodology, the assumptions regarding overall system efficiency and loads for typical equipment and end uses require that considerable judgment be exercised. This is particularly true for the space heating calculations. By using actual consumption data to inform and/or cross-check the assumptions regarding system efficiency and loads, the HA can "fine-tune" its allowance calculations developed with the engineering methodology.

To make the comparison, use billing data or checkmeter information to determine the mean consumption for each unit category. (See Chapter 6 for guidance on this process). Make sure the consumption data have been adjusted for vacancy. If the engineering-based amount is lower than the actual consumption, then one of two explanations may apply:

1) The mean consumption is higher than that of an energy conservative household, and the difference between mean consumption and the allowance is within the ability of the residents to control. This "excess" consumption may be due to use of appliances considered non-allowable by the HA, or to energy consumption habits that are not conservative.

2) The difference between the mean and the allowance is due to factors beyond the control of the residents, and assumptions in the engineering calculations may be inaccurate.

If the allowances calculated by the engineering-based method are more than 10 percent lower than the mean for actual consumption for each allowance category, the following steps should be taken:

1) ***Check the technical assumptions*** in the engineering calculations, such as the heat loss, the efficiency of the system, the heating degree days, design temperature differential, hot water temperature, etc.

2) ***Check for leaks and metering problems.*** Check for leaks in gas and water lines. Check the calibration of gas, water, and electricity meters. Verify that vacancy time has been excluded.

3) ***Survey households with the highest and lowest usage*** to evaluate consumption behavior patterns.

Step #15: Publish Allowances and Provide Residents an Opportunity to Comment

As indicated in Chapter 2, the HA must not only maintain a record that documents the basis upon which the utility allowances were established, but also must give notice to ***all*** residents of proposed allowances or revisions to allowances at least 60 days prior to the date the allowances are to become effective..

The notice to residents must include a description of the method for calculating the allowances, the specifics on where residents can obtain access to full documentation of the allowance methodology and calculations, notification of the residents' right to submit written comments, and information on the availability of individual relief for residents with special circumstances or needs.

Outreach Campaign on Energy Conservation

HAs should recognize the importance of an ongoing energy conservation education effort, particularly aimed at residents whose consumption exceeds their allowance. Such outreach and education efforts that result in more energy conservation by residents will not only benefit the individual households experiencing surcharges, but will also tend to reduce the HA's overall utility use and costs.

In addition, the HA should remain alert to weatherization measures and equipment upgrading that the agency could undertake that would reduce resident utility consumption.

USING THE ENGINEERING-BASED METHODOLOGY: EXAMPLES

This section of Chapter 5 illustrates each step of the methodology by guiding the reader through a series of examples. In each example, a fictitious housing development, Riverside Apartments, is used. For the steps that involve estimating the consumption requirements of an end-use (Steps #3 through #12), this section provides an example of how the HA calculates the consumption requirement for one allowance category ***(one-bedroom, end unit on the top floor)*** and explains how the process would differ for determining the consumption requirements for other allowance categories. The following examples are intended only as illustrations and that each HA must consider its own unique circumstances in establishing utility allowances for its developments.

Riverside Apartments, a fictitious site located in a region of moderate climate, is a 48-unit housing development consisting of six two-story buildings. Each building has eight apartments for families and has the following configuration:

1 BR Top End	2 BR Top Middle	1 BR Top Middle	2 BR Top End
1 BR Bottom End	2 BR Bottom Middle	1 BR Bottom Middle	2 BR Bottom End

All six buildings are of identical design and construction and are in the same physical condition. All the buildings have gas heat, hot water, and cooking. Refrigeration, lighting, and appliances are electric, and the apartments have hookups for electric clothes washers and dryers. Gas, electricity, and water are checkmetered. The HA provides trash pickup services, which are non-metered.

Step #1: Determining Which End-Uses Should Be Included in the Allowances

In determining which end-uses should be included in the allowances, the HA takes into account two items: (1) the metering configuration of the utilities, and (2) whether there are any end-uses that it considers non-allowable.

Metering Configuration. Because gas, electricity, and water are checkmetered at Riverside Apartments, allowances are provided for all three of these utilities. Because the HA provides trash pickup as a non-metered service, no allowance is provided for trash.

Non-allowable End-uses. The HA considers air conditioning a non-allowable end-use. Cooling fans, however, which the HA categorizes as a component of miscellaneous appliances, are considered allowable.

Therefore, the following end-uses are included in allowances at Riverside Apartments:

- space heating
- domestic hot water
- cooking
- refrigeration
- lighting
- miscellaneous electrical appliances (including fans)
- laundry
- water/sewer

Step #2: Developing the Allowance Categories

In developing the allowances categories, the HA considers the various factors outlined earlier in this chapter, which include:

- equipment and functions to be covered by the allowance
- dwelling unit size and number of occupants per dwelling unit
- construction and design of the housing development
- energy efficiency of HA-supplied appliances and equipment
- physical condition of the development
- indoor temperature

Following is a description of how the HA considers each factor and develops its allowance categories:

Equipment and Functions to be Covered by the Allowance. All six of the buildings of Riverside Apartments have the same types of utilities and equipment, so this factor does not affect the allowance categories. If some buildings had gas cooking, however, whereas others had electric cooking, or if some buildings had laundry hookups and others did not, then the HA would have to develop separate allowance categories for these buildings.

Dwelling Unit Size and Number of Occupants per Dwelling Unit. All of the apartments are either one-bedroom or two-bedroom. The HA assigns families to housing based on family size, and assumes two people per bedroom. Therefore, the HA bases its allowance categories on dwelling unit size in terms of number of bedrooms.

Construction and Design of the Housing Development. Riverside Apartments is the only development of this particular construction and design in the HA's portfolio; therefore, the HA does not group Riverside Apartments with any other development in establishing allowances. Further, all the buildings ***within*** Riverside Apartments are of the same construction and design, and therefore can be considered together in determining allowance categories. Because an allowance is provided for space heat, however, the HA also considers a ***unit's location within the building*** in developing allowance categories. Therefore, the HA forms categories that reflect whether the

dwelling unit is on the top floor or bottom floor, or if the apartment is an end unit or a middle unit. The HA has a heat loss calculation for each of these allowance categories.

Energy Efficiency of HA-supplied Appliances and Equipment. The heating and hot water systems and HA-supplied appliances are identical in each of the six buildings. Therefore, this factor is not a criterion in forming the allowance categories. If the efficiency of the heating or hot water systems or appliances differed significantly, however, then separate allowance categories would be required. For example, if the refrigerators in some of the buildings were significantly older or larger than refrigerators in other buildings, then separate allowance categories would be required.

Physical Condition of the Development. Because an allowance is provided for space heat at Riverside Apartments, the HA must consider the physical condition of the development. All the buildings were built at the same time, and they have all been modernized. Therefore, physical condition is not a criterion in forming the allowance categories. If some of the buildings had been modernized but others had not, however, then separate allowance categories based on building condition would be necessary.

Indoor Temperature. The indoor temperature is the same in all six of the buildings, so this factor is not a criterion in distinguishing allowance categories. If some of the buildings maintained a higher temperature in the winter, however, because their occupants were elderly or had special needs, then separate allowance categories would be required.

Allowance categories at Riverside Apartments are therefore distinguished by household size (in terms of number of bedrooms) and by a unit's location within the building. ***The unit's location within the building is only a consideration when calculating space heating energy consumption requirements. For other end-uses, consumption requirements can be calculated based on household size.***

The allowance categories at Riverside Apartments are therefore as follows:

1 BR End Top
1 BR End Bottom
1 BR Mid Top
1 BR Mid Bottom
2 BR End Top
2 BR End Bottom
2 BR Mid Top
2 BR Mid Bottom

Step #3: Estimating the Energy Consumption Requirements for Space Heating

Heat loss calculations were performed at Riverside Apartments five years ago, and no significant changes have been made to the buildings since then. Heat loss calculations are on file for the following categories of units:

Heat Loss Factors (Btus per Hour)

1 BR End Top	17,000
1 BR End Bottom	21,400
1 BR Mid Top	13,600
1 BR Mid Bottom	15,300
2 BR End Top	23,600
2 BR End Bottom	29,500
2 BR Mid Top	18,900
2 BR Mid Bottom	21,200

To calculate the space heating energy requirement for a 1 BR End Top unit, the following information is used:

- The heat loss is 17,000 Btu/hour (from the table above).
- The 30-year annual heating degree days are 5,003 (derived from Appendix C).
- The estimated efficiency of the heating system is 70 percent (derived from an energy audit of Riverside Apartments).
- The fuel type is gas and the fuel units are therms, so the Btu per fuel unit is 100,000 (from the table below).

1 kWh	=	3,413	Btus
1 ccf natural gas	=	100,000	Btus
1 thm natural gas	=	100,000	Btus
1 gallon No. 1 oil	=	134,950	Btus
1 gallon No. 2 oil	=	139,400	Btus
1 gallon No. 4 oil	=	145,600	Btus
1 gallon propane	=	91,600	Btus

- The indoor temperature in winter is 72°F and the outdoor design temperature is 10°F (derived from Appendix C), so the design temperature differential is 62°F.

$$\text{Annual Energy Consumption} = \frac{17{,}000 \text{ Btu/hr} \times 5003 \times 24 \text{ hrs}}{.70 \times 100{,}000 \text{ Btu/thm} \times 62°}$$

$$= \frac{2{,}041{,}224{,}000 \text{ Btu}}{4{,}340{,}000 \text{ Btu/thm}}$$

$$= 470 \text{ thm}$$

The annual space heating energy consumption requirement for a unit in the ***1 BR End Top*** category is therefore ***470 therms***. The annual space heating energy consumption requirements for other allowance categories are calculated in exactly the same way, changing only the heat loss factor.

Once the ***annual*** space heating consumption requirement is determined for an allowance category, the next step is to determine the ***monthly*** space heating consumption requirements for that allowance category. The ***monthly*** consumption requirements for this allowance category are calculated in the following table. The 30-year average ***monthly*** heating degree days (HDD) are divided by the 30-year average ***annual*** heating degree days to get the percent heating demand for each month. This percentage is then applied to the annual consumption requirement for heating to get the monthly consumption requirements.

Monthly Space Heating Energy Consumption Requirements, 1 BR End Top

Month	30-Year Average Monthly HDD	Divided by 30-Year Average Annual HDD	= Percent of Annual Heating Demand	x Annual Consump. (therms)	= Monthly Consump. (therms)
January	1150	5003	23%	470	108.1
February	901	5003	18%	470	84.6
March	652	5003	13%	470	61.1
April	250	5003	5%	470	23.5
May	85	5003	2%	470	9.4
June	0	5003	0%	470	0
July	0	5003	0%	470	0
August	0	5003	0%	470	0
September	40	5003	1%	470	4.7
October	253	5003	5%	470	23.5
November	654	5003	13%	470	61.1
December	1018	5003	20%	470	94.0

The monthly space heating energy consumption requirements for the 1 BR End Top allowance category are as follows:

Monthly Space Heating Energy Consumption Requirements (therms)

Riverside Apts.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1 BR End Top	108.1	84.6	61.1	23.5	9.4	0	0	0	4.7	23.5	61.1	94.0

The monthly space heating requirements for other allowance categories can be determined simply by using the same table, changing only the annual consumption amount (which must be specifically calculated for each allowance category).

Step #4: Estimating the Energy Consumption Requirements for Domestic Hot Water

The monthly hot water energy consumption requirement for a 1 BR End Top unit at Riverside Apartments is the same as it is for other one-bedroom units in the development. The following information is used to determine the monthly hot water energy consumption requirement for a one-bedroom unit at Riverside Apartments:

- The cold water temperature is 60°F (derived from the table below), and the hot water temperature is 120°F, so the temperature rise is 60°F.

Northern localities:	40 degrees
North Central localities:	50 degrees
Central localities:	60 degrees
Southern localities:	70 degrees

- There are low-flow showerheads and faucet aerators in all the units.
- The HA allows 25 gallons of hot water per person per day, and there are two people per unit, so a one-bedroom unit is allowed 50 gallons per day. This is equal to 1,550 gallons per month.
- The efficiency of the water heating equipment is 60 percent (based on an HA audit).
- The fuel type is gas and the fuel units are therms, so the Btu per fuel unit is 100,000 (from the table below).

1 kWh	=	3,413	Btus
1 ccf natural gas	=	100,000	Btus
1 thm natural gas	=	100,000	Btus
1 gallon No. 1 oil	=	134,950	Btus
1 gallon No. 2 oil	=	139,400	Btus
1 gallon No. 4 oil	=	145,600	Btus
1 gallon propane	=	91,600	Btus

$$\text{Monthly Energy Consumption} = \frac{60° \times 8.33 \text{ lbs/gal} \times 1550 \text{ gal}}{.6 \times 100{,}000 \text{ Btu/thm}}$$

$$= \frac{774{,}690 \text{ Btu}}{60{,}000 \text{ Btu/thm}}$$

$$= 12.9 \text{ thm}$$

The monthly hot water energy consumption requirement for all one-bedroom allowance categories at Riverside is 12.9 therms. This amount is the same for every month.

Monthly Domestic Hot Water Energy Consumption Requirements (therms)

Riverside Apts.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1 BR allowance categories	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9

The hot water energy consumption requirements for two-bedroom apartments are calculated in exactly the same way, changing only the number of gallons per apartment, which would be 100 gallons per day, or 3,100 gallons per month.

Step #5: Estimating the Energy Consumption Requirements for Cooking

Cooking at Riverside Apartments is provided by gas. The monthly cooking energy consumption requirement for a 1 BR End Top unit at Riverside Apartments is the same as it is for other one-bedroom units in the development. From the table below, the HA derives 5.4 therms as a monthly consumption amount for 1 BR apartments at Riverside.

Suggested Monthly Energy Consumption Requirements for Cooking

	0 BR	1 BR	2 BR	3 BR	4 BR	5 BR
Electric (kWh)	47 kWh	52 kWh	62 kWh	71 kWh	77 kWh	84 kWh
Gas (therms)	4.8 thm	5.4 thm	6.5 thm	7.4 thm	8.1 thm	8.8 thm
Propane (gal)	5.2 gal	5.9 gal	7.1 gal	8.1 gal	8.8 gal	9.6 gal

The monthly cooking energy consumption requirement for all one-bedroom allowance categories at Riverside is 5.4 therms. This amount is the same for every month.

Monthly Cooking Energy Consumption Requirements (therms)

Riverside Apts.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1 BR allowance categories	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4

The cooking energy consumption requirements for two-bedroom apartments are derived using the same table.

Step #6: Estimating the Energy Consumption Requirements for Refrigeration

All of the refrigerators at Riverside Apartments are 14 cubic foot refrigerators with a rated energy usage of 850 kWh per year (from procurement files). Therefore, the monthly refrigeration energy consumption requirement for a 1 BR End Top unit at Riverside Apartments is the same as it is for all other units in the development. The monthly energy requirement is simply the annual requirement (850 kWh) divided by 12 months, which is 71 kWh.

The monthly refrigeration energy consumption requirement for all allowance categories at Riverside is 71 kWh. This amount is the same for every month.

Monthly Refrigeration Energy Consumption Requirements (kWh)

Riverside Apts.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
All allowance categories	71	71	71	71	71	71	71	71	71	71	71	71

Step #7: Estimating the Energy Consumption Requirements for Lighting

The monthly lighting energy consumption requirement for a 1 BR End Top apartment is the same as it is for other one-bedroom apartments at Riverside. To calculate the electricity requirements for lighting for a one-bedroom unit at Riverside Apartments, the HA uses the following assumptions, based on information it has on the lighting in the apartments, and on what it considers to be a reasonable number of hours for lights to be on every day in each room:

- The living room has two 75-Watt bulbs; these lights are on an average of five hours/day.
- The kitchen has two 75-Watt bulbs; these lights are on an average of four hours/day.
- The pantry has one 60-Watt bulb; this light is on an average of one hour/day.
- The hall has one 75-Watt bulb; this light is on an average of two hours/day.
- The bathroom has one 50-Watt bulb (fluorescent); this light is on an average of three hours/day.
- The bedroom has two 75-Watt bulbs; these lights are on an average of four hours/day.

- The porch has two 75-Watt bulbs; these lights are on an average of three hours/day.

1) For each room in the dwelling unit, add together the wattage of the light bulbs to obtain the total ***Watts (W) for each room.***

Living room	75 W + 75 W	=	150 W
Kitchen	75 W + 75 W	=	150 W
Pantry	60 W	=	60 W
Hall	75 W	=	75 W
Bathroom	50 W	=	50 W
Bedroom	75 W + 75 W	=	150 W
Porch	75 W + 75 W	=	150 W

2) Multiply the Watts for each room by the number of hours the lights are on per day in that particular room to get ***daily Watt-hours (Wh) for each room.***

Living room	150 W	x	5 hrs/day	=	750 Wh
Kitchen	150 W	x	4 hrs/day	=	600 Wh
Pantry	60 W	x	1 hr/day	=	60 Wh
Hall	75 W	x	2 hr/day	=	150 Wh
Bathroom	50 W	x	3 hr/day	=	150 Wh
Bedroom	150 W	x	4 hr/day	=	600 Wh
Porch	150 W	x	3 hr/day	=	450 Wh

3) Add together the Watt-hours for each room to get ***daily Watt-hours for the dwelling unit.***

Living room	750 Wh/day
Kitchen	600 Wh/day
Pantry	60 Wh/day
Hall	150 Wh/day
Bathroom	150 Wh/day
Bedroom	600 Wh/day
Porch	450 Wh/day
Total for Dwelling Unit	2,760 Wh/day

4) Divide the total Watt-hours by 1000 to convert the Watt-hours into ***daily kiloWatt-hours (kWh) for the dwelling unit.***

2,760 Wh/day ÷ 1000 Wh/kWh = 2.76 kWh/day

5) Multiply the kWh calculated in Step 3 by 31 to determine ***monthly kWh for the dwelling unit.***

2.76 kWh/day x 31 days/month = 86 kWh/month

The monthly lighting energy consumption requirement for all one-bedroom allowance categories is 86 kWh. This amount is the same for every month.

Monthly Lighting Energy Consumption Requirements (kWh)

Riverside Apts.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1 BR allowance categories	86	86	86	86	86	86	86	86	86	86	86	86

The lighting energy consumption requirements for two-bedroom apartments are calculated in the same way, but with increased wattages for the bedrooms (because there are two bedrooms rather than one) and increased burn times for some of the rooms, in particular the living room, kitchen and bathroom.

Step #8: Estimating Energy Consumption Requirements for Miscellaneous Electric Appliances

At Riverside Apartments, clocks, televisions, radios, toasters, microwave ovens, blenders, coffee makers, irons, vacuum cleaners, cooling fans, and other small appliances are considered legitimate end-uses and are included in the miscellaneous allowance category. The HA recognizes that there may be other legitimate end-uses that it has not listed.

The monthly energy consumption requirement for miscellaneous electric appliances for a 1 BR End Top apartment is the same as it is for other one-bedroom apartments at Riverside. ***Using a table of standard consumption levels, which the HA obtained from the local utility***, the HA estimates that all the items listed above use roughly 900 kWh per year for a household living in a one-bedroom apartment. An additional 300 kWh per year is added to cover the use of other small appliances that are not listed but that are legitimate uses of electricity for an energy-conservative household of modest means. The total annual consumption requirement is therefore 1200 kWh, which is ***100 kWh*** per month.

The monthly energy consumption requirement for miscellaneous electric appliances for all one-bedroom allowance categories is 100 kWh. This amount is the same for every month.

Monthly Energy Consumption Requirements for Miscellaneous Electric Appliances (kWh)

Riverside Apts.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1 BR allowance categories	100	100	100	100	100	100	100	100	100	100	100	100

The consumption requirements for two-bedroom apartments are calculated in the same way, but with increased assumptions of usage.

Step #9: Estimating the Energy Consumption Requirements for Laundry

The monthly laundry energy consumption requirement for a 1 BR End Top apartment is the same as it is for other one-bedroom apartments at Riverside. To estimate the electricity requirements for clothes washers and dryers for one-bedroom units of Riverside Apartments, the HA uses the tables below:

Monthly Electric Consumption Requirements of a Typical Clothes Washer

	0 BR	1 BR	2 BR	3 BR	4 BR	5 BR
Clothes washer (600-Watt)	2.5 kWh	5 kWh	10 kWh	15 kWh	20 kWh	25 kWh

Monthly Energy Consumption Requirements of Clothes Dryers

	0 BR	1 BR	2 BR	3 BR	4 BR	5 BR
Electric dryer (5000 Watts)	30 kWh	60 kWh	120 kWh	180 kWh	240 kWh	300 kWh
Gas dryer (.22 therms/hr)	1.5 thms	3 thms	6 thms	8 thms	11 thms	13 thms

The monthly energy consumption requirement for laundry for all one-bedroom allowance categories is 5 kWh plus 60 kWh, which totals 65 kWh. This amount is the same for every month.

Monthly Laundry Energy Consumption Requirements (kWh)

Riverside Apts.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1 BR allowance categories	65	65	65	65	65	65	65	65	65	65	65	65

The consumption requirements for two-bedroom apartments are derived using the same tables.

Step #10: Estimating the Energy Consumption Requirements for Air Conditioning

Because the HA does not provide an allowance for air conditioning, the HA skips this step. The energy consumption requirement for cooling fans, which are allowable, are determined in Step #8, which estimates the consumption requirements for miscellaneous electric appliances.

Step #11: Estimating the Consumption Requirements for Water

The monthly consumption requirement for water for a 1 BR End Top apartment is the same as it is for other one-bedroom apartments at Riverside. The dwelling units at Riverside Apartments have low-flow showerheads and low-volume flush toilets. The HA considers 60 gallons per person per day a reasonable amount. One-bedroom units are allowed 120 gallons per day, because the HA assumes two persons per one-bedroom apartment. The HA then multiplies this daily amount by 31 days to get the monthly amount, which is 3,720 gallons per one-bedroom unit.

Because the water utility charges per hundred cubic feet (ccf) rather than per gallon, the HA must convert the gallon consumption requirement into ccf. This conversion is done by multiplying the gallons by 0.001337:

$$3{,}720 \text{ gallons} \times 0.001337 = 4.97 \text{ ccf}$$

The monthly consumption requirement for water for all one-bedroom allowance categories is 4.97 ccf. This amount is the same for every month.

Monthly Water Consumption Requirements (ccf)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1 BR allow. categories	4.97	4.97	4.97	4.97	4.97	4.97	4.97	4.97	4.97	4.97	4.97	4.97

The consumption requirements for two-bedroom apartments are derived in the same way, changing the daily per-unit amount to 240 gallons because there are assumed to be four people per dwelling unit. This amount is then multiplied by 31 days to get a monthly amount, which in then converted into ccf.

Step #12: Estimating the Consumption Requirements for Trash/Garbage

Because the HA does not provide an allowance for trash pickup, the HA skips this step.

Step #13: Aggregating Component Consumption Amounts for Each Utility

The HA has now calculated all the component monthly consumption allowances of one allowance category (1 BR End Top apartment) for Riverside Apartments. The next step is to aggregate the component consumption amounts for each utility.

For the total gas consumption allowance, the HA adds together the monthly component consumption requirements for gas end-uses: space heating, domestic hot water, and cooking.

Monthly Gas Allowances (therms), 1 BR End Top

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Heat	108.1	84.6	61.1	23.5	9.4	0	0	0	4.7	23.5	61.1	91.0
DHW	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9
Cooking	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4
Total	126.4	102.9	79.4	41.8	27.7	18.3	18.3	18.3	23.0	41.8	79.4	109.3

For the total electricity allowance, the HA adds together the monthly component consumption requirements for refrigeration, lighting, miscellaneous electric appliances, and laundry.

Monthly Electricity Allowances (kWh), 1 BR

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Refrig.	71	71	71	71	71	71	71	71	71	71	71	71
Lighting	86	86	86	86	86	86	86	86	86	86	86	86
Misc. appl.	100	100	100	100	100	100	100	100	100	100	100	100
Laundry	65	65	65	65	65	65	65	65	65	65	65	65
Total	322	322	322	322	322	322	322	322	322	322	322	322

Because there is only one component to the water allowance, the HA needs only to transfer the amounts derived in Step #11 to the table.

Monthly Water Allowances, 1 BR

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
ccf	4.97	4.97	4.97	4.97	4.97	4.97	4.97	4.97	4.97	4.97	4.97	4.97

Step #14: Converting Consumption Allowances to Dollar Allowances

At this point, the HA has determined the monthly consumption allowances for gas, electricity, and water for one allowance category. The HA must then convert the consumption allowances for each utility by multiplying the consumption allowance by the rate that is applicable for that particular month.

Gas. The current gas rate is $0.65/therm for December through March, and $0.55/therm for April through November.

Monthly Gas Allowances, 1 BR End Top

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Consump. allow. (therms)	126.4	102.9	79.4	41.8	27.7	18.3	18.3	18.3	23.0	41.8	79.4	109.3
× rate ($/therm)	.65	.65	.65	.55	.55	.55	.55	.55	.55	.55	.55	.65
Dollar allow. ($)	$82	$67	$52	$23	$15	$10	$10	$10	$13	$23	$44	$71

Electricity. The current electric rate is $0.10/kWh for June through September, and $0.085/kWh for October through May. There is no demand charge.

Monthly Electricity Allowances, 1 BR End Top (same for all 1 BR allowance categories at Riverside Apartments)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Consump. allow. (kWh)	322	322	322	322	322	322	322	322	322	322	322	322
× rate ($/kWh)	.085	.085	.085	.085	.085	.10	.10	.10	.10	.085	.085	.085
Dollar allow. ($)	$27	$27	$27	$27	$27	$32	$32	$32	$32	$27	$27	$27

Water. The current water rate is $2.00 per ccf for water, and $1.00 per ccf for sewer. These rates do not vary seasonally. The HA adds these together for a rate of $3.00/ccf.

Monthly Water/Sewer Allowances, 1 BR (same for all 1 BR allowance categories at Riverside Apartments)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Consump. allow. (ccf)	4.97	4.97	4.97	4.97	4.97	4.97	4.97	4.97	4.97	4.97	4.97	4.97
× rate (water + sewer) ($/ccf)	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Dollar allow. for water	$15	$15	$15	$15	$15	$15	$15	$15	$15	$15	$15	$15

To finish the utility allowance calculation in dollars, the HA now adds together the dollar allowances for all the covered utilities, for the 1BR End Top apartments.

Total Monthly Utility Allowances, 1 BR End Top

Riverside Apts. 1 BR End Top	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
$ Allowance —Gas	$82	$67	$52	$23	$15	$10	$10	$10	$13	$23	$44	$71
$ Allowance —Electric	$27	$27	$27	$27	$27	$32	$32	$32	$32	$27	$27	$27
$ Allowance —Water/ Sewer	$15	$15	$15	$15	$15	$15	$15	$15	$15	$15	$15	$15
$ Allowance —All Utilities	$124	$109	$94	$65	$57	$57	$57	$57	$60	$65	$86	$113

OPTION: COMPARING THE OLD AND NEW UTILITY ALLOWANCES

Most HAs going through the process of calculating utility allowances will be replacing an old allowance schedule with a new one. When all the calculations are completed, it is important to look at the new allowance schedule as compared to the old one and consider the effect of the changes. This is a particularly vital step if the HA is changing the methodology being used, because it is possible that the engineering methodology will produce quite different allowances than the consumption methodology.

As a rule of thumb, if the allowances are more than 10 percent lower, the engineering calculations should be re-examined. See pages 61-62 of this chapter for steps to take.

Making this comparison between old and new allowance is of ***limited value*** when there have been significant changes made to the buildings (rehab or repairs, weatherization) or the HA-supplied equipment, or when the allowable end-uses have been changed, but it is still a useful step for the HA, because large changes in the allowances are more likely to bring resident comments, questions, or challenges.

The larger the dollar changes—even though the calculations are correctly done and fully documented—the more care the HA will want to put into explaining the new allowances and helping residents adjust to them. Particularly if the allowances are decreasing, the HA might want to take advantage of conservation materials available from a local utility company or weatherization program and conduct an education campaign for residents about how they can conserve energy and avoid or minimize surcharges.

If the HA is switching for the first time to individual metering or checkmetering (after paying all or nearly all utilities in the past), it is especially important to inform the residents about the changes and explain the changes in rent as they relate to the allowances.

Question & Answer Exercise for Chapter 5

Questions

1. **Which of the following items is required to calculate the consumption requirements for space heat, using the engineering-based methodology?**

   (a) heating degree days
   (b) heat loss calculation for each category of dwelling unit
   (c) information on the efficiency of the heating system
   (d) design temperature differential
   (e) all of the above

2. **Which of the following factors affect a household's energy requirement for domestic hot water?**

   (a) the temperature of the water before and after it is heated
   (b) whether the dwelling unit has water-saving devices installed
   (c) the number of persons in the household
   (d) the efficiency of the hot water heater
   (e) all of the above

3. **Which of the following factors affect a household's electricity requirements for lighting?**

   (a) the number of light bulbs in a dwelling unit
   (b) the wattage of the light bulbs in a dwelling unit
   (c) how many hours the lights are on every day
   (d) all of the above

4. **How should an HA estimate the consumption requirement for refrigeration?**

   (a) using standard consumption tables
   (b) with a formula
   (c) using in-house information from procurement records or refrigerator labels
   (d) contacting the local utility
   (e) all of the above

Question & Answer Exercise for Chapter 5

Answers

1. (e) all of the above. All of these pieces of information are required to estimate the consumption requirements for space heating.

2. (e) all of the above. Energy requirements for hot water depend on the temperature of the water before and after it is heated, on whether there are water-saving devices installed in the dwelling units, on the number of persons in the household, and on the efficiency of the water heating system.

3. (d) all of the above. Electricity requirements for lighting depend on the number of light bulbs in a dwelling unit, the wattage of those light bulbs, and how many hours they are on.

4. (c) using in-house information from procurement records or refrigerator labels. Because the consumption requirements for refrigeration range widely, depending on the age and size of the refrigerator, HAs should use in-house information, rather than relying on standard consumption tables.

CHAPTER 6: ESTABLISHING ALLOWANCES USING CONSUMPTION DATA

Overview

With the consumption-based methodology, HAs use actual historic consumption data from dwelling units to establish utility allowances. These data are in the form of utility billing records (where utilities are individually metered) or checkmeter records (where utilities are check-metered). Allowances are calculated separately for each utility for which an HA provides an allowance.

Because it focuses on recent experience at the HA, the consumption-based methodology generally reflects changes in the condition of the dwelling units, in equipment operation and in resident population and behavior more readily than does the engineering methodology. However, by focusing on actual resident utility consumption rather than on recommended standards for utility use, the consumption methodology also tends to give less emphasis on energy-conservation. In order words, if there is a trade-off between minimizing resident utility surcharges and maximizing energy conservation by residents, the consumption methodology will tend to favor the former over the latter.

There is sometimes a perception that the consumption-based methodology is less complicated for HAs to use (or less dependent on outside technical assistance) than the engineering methodology. This may be true in some cases, if the historical utility data are readily available, the HA has a very homogeneous resident population, and most of the HA's units are very similar in terms of construction type, utility configuration, and age of equipment and materials. However, as the reader will see as we proceed through this chapter, the consumption-based methodology can also prove to be quite complex at times, particularly around the issue of selecting a sample of units which will provide ***statistically valid*** utility consumption data.

"Statistically valid" means that the data for the sample provide a good approximation of the experience of all the units in the category being studied. One straightforward approach to satisfying this sampling issue is to include the data from all the HA's units ("100 percent sampling"). However, if the HA does not have the capacity (or desire) to include all units in its calculations, then the HA will need to determine what is an acceptable sample size for each allowance category, and how to achieve these sample sizes. As will be discussed in this chapter, in cases where the amount of consumption data available to the HA is limited, the HA will often be required to make mathematical adjustments in the data for

units with vacancies or unallowable end uses, etc., in order to be able to reach the sample size necessary for statistical validity.

As described in this chapter, the process for calculating utility allowances using actual consumption data involves the following steps:

- specifying allowable and non-allowable end-uses
- determining the timeframe covered by the historic consumption data
- defining allowance categories
- collecting the consumption data and grouping the data by allowance categories
- cleaning the data and checking for statistical validity
- calculating typical consumption levels
- establishing the standards for "energy-conservative households"
- converting the consumption allowances into dollar allowances

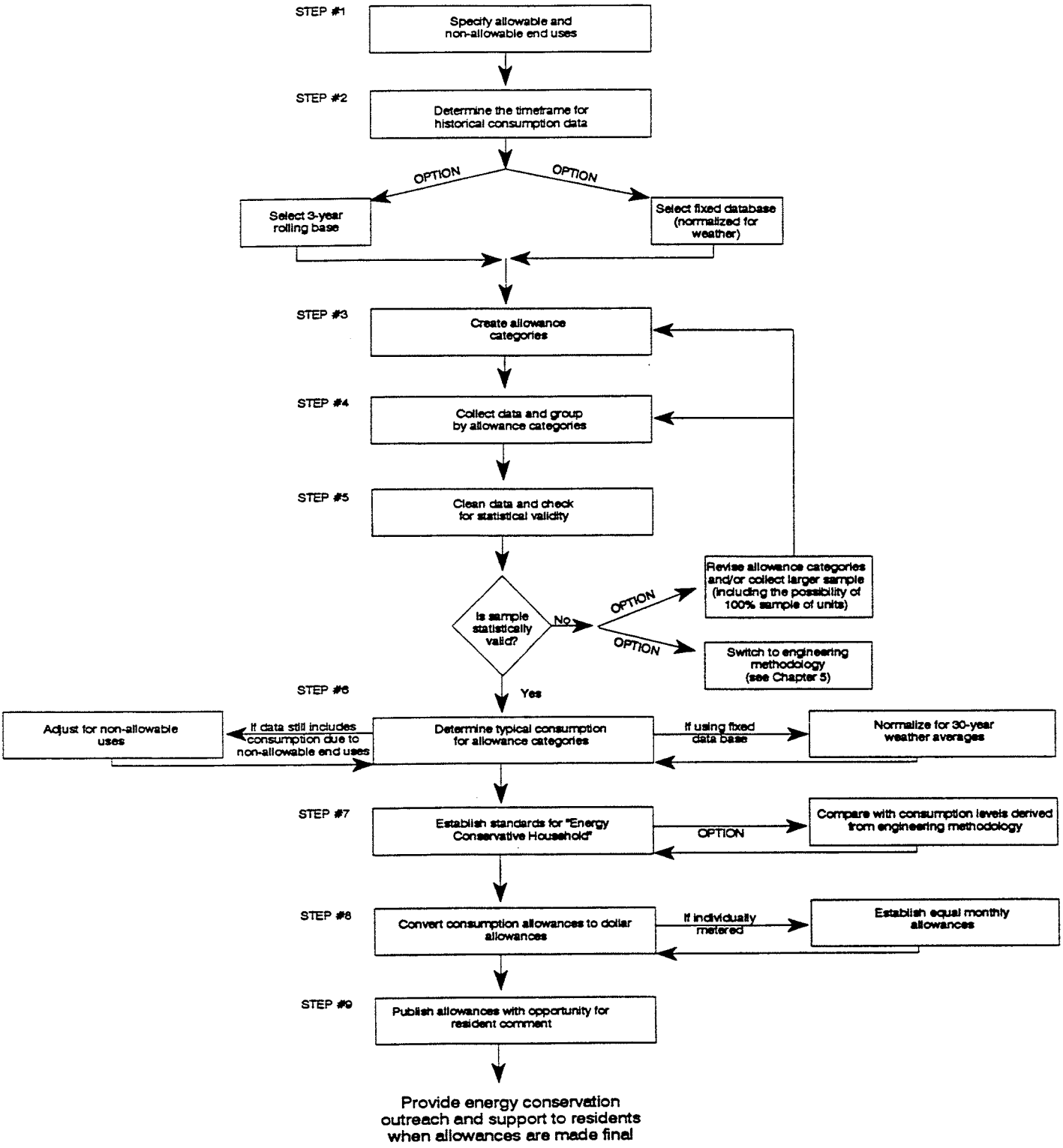
Exhibit 6.1 presents a schematic representation of this process. ***Note: It is important for the HA to recognize from the exhibit that the outlined steps are interdependent and not purely sequential. For example, in order to achieve statistical validity (see Step #5 in the exhibit), the HA may need to go back and revise allowance categories (Step #3) or sample more units (Step #4).***

After describing these individual steps, the chapter presents an example in which the utility allowances for a fictitious public housing development, ***Elm Street Apartments***, are calculated using the consumption based methodology.

Again, it is important for the reader to keep in mind that the specific approach to the consumption-based method described in this chapter is recommended, and not mandated. The federal regulations are quite clear in indicating that ***the complexity and elaborateness of the method chosen by an HA should be a reflection of the data available to the agency and the extent of administrative resources reasonably available*** to the HA to be devoted to the calculation of the allowances.

However, this chapter provides the rationale for each step in the process recommended, and attempts to demonstrate how the overall approach being presented represents a "best practice" for establishing allowances based on consumption records.

Exhibit 6.1
Steps in the Consumption-Based Methodology



Step #1: Defining Allowable and Non-Allowable End-Uses

Before establishing allowances, an HA must determine if there are any end-uses it will specifically exclude from the utility allowances, thereby considering them ***non-allowable end-uses***. Some end-uses, may be considered allowable by one HA but non-allowable by another HA. Even within one HA's portfolio, some end-uses may be considered allowable for some units but non-allowable for others. This decision is left to the HA to make, based on local custom and usage patterns as well as local climate. ***(Please refer to Chapter 2 for a discussion of air conditioning.)***[1]

If an HA considers any end-uses to be non-allowable, then the consumption data should be adjusted to reflect this fact. This adjustment process is described later in this chapter. Where an end-use is allowable for some dwelling units but not for others, separate allowance categories should be developed for each grouping of units.

Step #2. Determining the Time Frame of the Historic Consumption Data

Within the consumption-based methodology, ***an HA has several different options*** relative to defining the time period covered by the historic consumption data that are used. This chapter will consider two options: the ***three-year rolling base*** approach and the ***weather-normalization*** approach.

Option #1: Three-Year Rolling Base. A common approach to calculate allowances is to use a three-year "rolling base" of consumption data. Allowances are calculated using data from three successive years; by using data from multiple years in the calculation, the impact on the allowance of single-year fluctuations in weather patterns is reduced. The term "rolling base" means that every year the oldest year's data are thrown out, and the most recent year's data are added to the database.

Advantages of the three-year rolling base:

- With three years of data, it may be easier to attain a sufficient sample size necessary for statistical validity.
- A rolling base will incorporate changes in consumption patterns over time that result from resident turnover, gradual changes in the number and type of appliances, and physical changes to the buildings.

[1] It is important to note that air conditioning and cooling are not synonymous. Cooling includes air conditioning and fans. In some cases, fans may be allowable where air conditioning is not.

Disadvantages of the three-year rolling base approach:

- The HA must obtain consumption data every year.
- The HA must recalculate the allowances every year.

Option #2: Fixed Database Normalized for Weather. An alternative way to calculate allowances is to use a fixed base of consumption data from one or more years,[2] adjusted (or "normalized") for the effects of weather. This approach is appropriate only where an allowance is provided for space heat.[3] The process of "weather normalization" can be performed using weather data from the years in which the consumption data are taken as well as the 30-year weather data averages. The weather data for the relevant years can be obtained from the local weather station, as can the 30-year weather data. Appendix C also provides 30-year average weather data for various locations throughout the country.

To use this approach, follow the instructions throughout this chapter as for the three-year rolling base method. Then follow the process for normalizing the weather data described at the end of the chapter.

Advantages of the normalized fixed database approach:

- It goes much further than the rolling-base approach in ensuring that the allowances are based on typical weather patterns, rather than reflecting short-term variations in the weather.
- The HA may not have to obtain consumption data every year.
- The HA does ***not*** need to recalculate allowances every year, and the annual review process is relatively simple.

[2] If this approach is used to calculate allowances for individually metered propane or oil, three years of data should be used for the fixed base.

[3] This approach should only be used if space heating represents a substantial portion of the utility consumption. This is generally the case, even when the utility is used for other end-uses, such as hot water heating and cooking. However, where the heating load does not represent a substantial portion of the consumption, such as may be the case in regions with extremely mild winters, then the weather-normalization approach should not be used.

Disadvantages of the normalized fixed database approach:

- The HA must obtain weather data for the year(s) in which the consumption data were taken.

- A fixed database does not reflect changes in consumption over time that result from resident turnover, gradual changes in the number and type of appliances, or physical changes to the buildings. ***Therefore, the HA should recalculate the allowances every five years or so, using new data, to account for these changes.***

Step #3: Developing the Appropriate Allowance Categories

As noted in Chapter 2, different categories of allowances are necessary because different types of dwelling units have varying consumption requirements. ***Allowance categories*** should be distinguished by characteristics that significantly affect the consumption requirements of a dwelling unit. These characteristics may include any of the following factors:

- equipment and functions to be covered by the allowance
- climatic conditions
- dwelling unit size
- number of occupants
- type of construction and design of the housing development
- energy efficiency of appliances and equipment
- physical condition of the development
- indoor temperature
- hot water temperature

The establishment of the allowance categories is one of the most critical steps in the consumption-based methodology, because these decisions will significantly influence not only the fairness of the allowances which are generated, but also the amount of work that the HA will need to perform in calculating them.

How Many Allowance Categories Must an HA Establish?

The federal regulations require that a broad range of factors be examined to determine their potential bearing on the allowances, and whether separate categories should be established which distinguish among these factors. However, each allowance category which is created requires a separate set of calculations to be performed. Thus, the process of defining the allowance categories involves finding a proper balance between the administrative burden of large numbers of categories and the inequities which might result from the failure to recognize appropriate factors accounting for significantly different consumption requirements among households.

There is no "magic number" which represents the ideal number of allowance categories for all HAs. The appropriate number will vary according to the characteristics of an HA's residents, physical stock, and utility configurations, and the amount of variation within each of these elements.

As suggested previously, some of the factors which could be expected to affect consumption requirements are the ***characteristics of residents*** (for example, seniors versus families), ***construction and design*** of the housing development, ***energy efficiency*** of appliances and equipment provided, and (where the allowance covers space heating) the ***physical condition*** of the development. However, ***within a single public housing development***, these characteristics could be expected to be fairly consistent across all units. Therefore, the allowance categories established for an individual development may not need to distinguish among these factors.

On the other hand, even within a single public housing development, there are a number of factors which can be expected to account for considerable variation in reasonable consumption requirements among households. At a minimum, for each utility function, separate allowance categories should be established that distinguish between ***dwelling units of different sizes*** (in terms of number of bedrooms). For space heating or cooling allowances in multi-unit buildings, allowance categories should also be created that differentiate the ***configuration or location*** of a unit within the building (for example, the number of exterior walls the unit has, or whether the unit is on the top floor or bottom). The HA should also examine whether it may be appropriate to develop separate allowance categories based on ***numbers of occupants per unit***, particularly for the largest sized units, or for households which are either over-housed or under-housed in terms of number of bedrooms.

Thus, at the level of the individual housing development, the number of separate allowance categories which are necessary may prove to be reasonably limited, while still meeting the federal requirements.

Step #4: Collecting the Consumption Data and Grouping the Data by Allowance Categories

Consumption data are obtained from checkmeter records or utility billing records that show the number of units of energy (kWh of electricity, therms or ccf of gas, gallons of oil or propane) or water (gallons or ccf) consumed over a given period of time. Each piece of consumption data depicts the amount of energy or water that a dwelling unit consumed during a certain period.

HAs that provide allowances for more than one utility (for example, electricity, gas, and water) must collect consumption data for each of those utilities. Three years of data should be collected, unless the "weather normalization" approach is taken, in which case one or more years of data is needed.

Individually metered utilities. For individually metered utilities, the HA must obtain consumption records from the local utility. Each record shows the total amount of energy or water consumed by the household during a monthly or, in some cases, a bi-monthly period.

Generally, utilities require that the HA present a release form that has been signed by the resident before releasing that resident's record. For oil or propane (non-checkmetered), consumption data may be obtained from the residents or from the fuel company. Because oil and propane are delivered at irregular intervals, the data for each dwelling unit in a given year should be totaled to obtain an annual amount for each dwelling unit.

Checkmetered utilities. Where utilities are checkmetered, checkmeters should be read by the HA routinely at regular intervals, preferably every month, although some HAs read checkmeters bi-monthly or quarterly. The records of these periodic checkmeter readings provide the consumption data. Each record shows the total amount of energy or water consumed by the dwelling unit during that particular period.

The next step is to group the consumption data according to the ***allowance categories*** that have been established. Consumption data for all the dwelling units in a given allowance category should be grouped together. If the consumption records are on paper, such as copies of utility bills, then the HA should group the consumption records together by hand according to allowance category.

The consumption amount from each checkmeter or billing record in a given allowance category should be entered onto a separate table or spreadsheet. There should be one table for each allowance category for each utility allowance being calculated. Within each table, there should be a separate column for each month, bi-monthly period, or quarter,

whichever is the appropriate billing period. (For non-checkmetered oil or propane, there should be only one column in each table because the amounts are annual.) The data records from the dwelling units in an allowance category for a given time period represents the ***data set*** or sample for that allowance category.

The following table shows how the data in a sample might be organized for a single allowance category:

Elm Street Apartments: 2-BR, Top Floor, End Units
kWh

Yr	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Monthly Average for Year
1993	A-7													
	A-9													
	B-7													
	B-9													
	C-7													
	C-9													
1994	A-7													
	A-9													
	B-7													
	B-9													
	C-7													
	C-9													
1995	A-7													
	A-9													
	B-7													
	B-9													
	C-7													
	C-9													
Measure of central tendency														

NOTE: For this example, there are only 6 units in this particular allowance category.

Where possible and practical, data from all the dwelling units in an allowance category should be obtained (known as a "100% sample"). In some cases, however, a smaller, ***representative sample*** of data may be used for each allowance category. If a smaller sample is used, there should be enough data in each allowance category to render the data set ***statistically valid***.

Step #5: Cleaning the Consumption Data and Checking the Statistical Validity of the Sample

Overview: This section discusses the distinct but inter-related activities of ***cleaning the collected data*** and assessing the overall ***statistical validity*** of the sample. The former activity is concerned with trying to ensure that the consumption data for each dwelling unit included in the sample do not reflect features that might make the unit an inappropriate example of consumption levels, or provide inaccurate information. The latter activity (assessing statistical validity) is concerned with the dependability of the overall sample in depicting consumption typical of all units in the allowance category.

Problems regarding the accuracy or appropriateness of consumption data for a particular dwelling unit can derive from a number of sources, including ***vacancies***, ***estimated readings***, ***non-allowable end-uses*** and ***inaccurate meters***. There are basically two ways to deal with, or "clean", such data problems. The easiest approach is for the HA to eliminate from the sample any dwelling units which have such data problems. For example, the HA might want to exclude from the sample any units which have "estimated" (rather than actual) readings that are not corrected by subsequent actual meter readings, in order to ensure that the consumption data for the period examined as much as possible represents actual experience and not just an approximation.

However, it can be seen that this approach could significantly reduce the HA's overall sample size for an allowance category. As will be discussed in more detail later in this chapter, the statistical validity of the sample is dependent on achieving a final sample size that is sufficiently large in relation to the overall number of units in the allowance category. Therefore, it may not be possible to simply discard all units having apparent data problems and still be able to achieve a statistically valid sample for the allowance category. For example, in considering their data cleaning strategy, the following provides HAs with a rough "rule of thumb" for valid sample sizes:

Estimate of Valid Sample Sizes for Number of Units After Cleaning

If the sample size for an allowance category after cleaning is:

less than 6 units	->	*add those units to another similar category*
6 - 25 units	->	*use all of the units in calculations*
more than 25 units	->	*select a random sample of at least 26 units, sort the units by usage, and then drop the top three units and the bottom three units. The remaining sample of units can then be used to calculate "typical" consumption for the category.*

The dependability of this "rule of thumb" approach is improved if the HA has removed units containing unallowable end-uses from the sample.

Note: This table provides a rough estimate of the minimum sample size which could be expected to generate a valid sample when the allowance categories are relatively small. It is primarily meant to serve as a tool to help HAs in planning their data cleaning strategy, particularly when the amount of data available is limited. For a precise assessment of statistical validity, especially for larger allowance categories, the HA should use the formulas for sample size and variance found later in this chapter.

From this it can be seen that if the sample size is too small, the only way to achieve statistical validity is to merge allowance categories, which might create some inequities in the resulting allowances (for example, if the categories for modernized units were merged with units not yet upgraded).

To achieve larger sample sizes, the alternative approach to data cleaning is to delete or adjust the data ***for just those time periods in which the data problems occur,*** in order to permit the rest of the data for a dwelling unit to remain in the sample.

As can be seen from this discussion, under the consumption-based methodology, all data cleaning must proceed with an eye to the ultimate impact on final sample size. The following provides some additional discussion of this data cleaning process. At the end of the discussion of data cleaning, details on the assessment of statistical validity are presented.

Data Cleaning

The elements of data cleaning in part depend on how the utilities are metered:

Individually metered utilities. For individually metered utilities, if there are more than two months in a row of "estimated" reads for a particular dwelling unit, and these estimated reads are not corrected by subsequent actual meter readings, then the records for this unit should be removed from the database.

In addition, any monthly or bi-monthly utility record from a dwelling unit that was unoccupied during the time period covered by the monthly or bi-monthly record should be removed from the database. Obviously, a period of vacancy will reduce utility use for a unit. Including data from vacant units would likely result in overall consumption figures for the time period examined that are not typical of the occupied units. Therefore, such records should be excluded from the allowance calculation.

Similarly, for oil or propane, if any dwelling unit was vacant for more than two of the months of the heating season covered by consumption data within a given year, the whole year of data should be excluded from the database, because the two months could constitute a significant portion of the annual total.

If a unit has non-allowable end-uses, and the sample of dwelling units in an allowance category is large enough, the HA may simply want to delete all data on those units with such end-uses. If the HA feels that it needs to maintain these units in its sample, it should follow the directions regarding adjustments for non-allowable end-uses that appears at the end of the description of Step #6.

Checkmetered utilities. Checkmeter reading records should reflect readings made at regular intervals. If readings were made sporadically or at irregular intervals, the records from these readings should not be used or should be adjusted to reflect consistent time periods. This adjustment can often be accomplished by dividing the reading by the number of days between readings to get average use per day, and multiplying that number by a standard number of days.

As with individually metered utilities, consumption records from dwelling units that were vacant during the period covered by the data should be removed from the database. Non-allowable end-uses should also be addressed as described in the previous section on individually metered utilities.

Finally, to ensure the quality of checkmetered data, the total of all the checkmetered consumption data should be checked against the master-metered total, and:

- If the master-metered total is higher or lower than the checkmetered total ***by more than two percent***, then a sample of the checkmeters should be checked for calibration problems. Any miscalibrated checkmeters should be recalibrated. If it is found that the checkmeters are calibrated properly, gas or water lines should be checked for leaks, and electricity distribution lines should be checked for power losses.

- If the master-metered total is higher or lower than the checkmetered total ***by more than ten percent***, then the consumption records are of unacceptable quality and the HA should not use the consumption-based methodology. Instead, the engineering methodology should be used.

Following is a more detailed discussion of statistical validity and the elements which affect it.

Statistical Validity

A statistically-valid data set for an allowance category has enough data in it to derive a reasonably accurate measure of the typical utility consumption experience for that category of dwelling units. In other words, statistical validity is an indication of the level of confidence that any average calculated for the sample (data set) is a close approximation of the true average for all the units in the allowance category.

The most important thing to remember is that ***unless the sample of data used for an allowance category is statistically valid***, the results of the calculations using such data cannot be trusted, and ***the consumption method should not be used.***

Note: If an HA is using all the units from the allowance category as part of its sample (i.e., a 100% sample), there is no need to check for statistical validity.

Assume that the standard for statistical validity is that there must be a ***95 percent probability*** that the average from the sample is ***within 10 percent***

of the true average for the allowance category; that is, there is a high degree of confidence that the estimate of the typical consumption is accurate to within 10 percent of the actual average consumption across the units in the allowance category. To determine how large a sample is needed to meet this standard, the following formula would be used:

$$\text{valid sample size} = \frac{3.84 * Var}{(0.10 * Avg)^2}$$

where *Var* stands for ***variance*** and *Avg* stands for the ***average monthly consumption across the dwelling units in the sample.***

For present purposes, the ***variance*** is a measure of the extent to which the values of the annual average consumption of the ***individual dwelling units*** in the sample differs from the average consumption computed ***for the overall sample.***

It is essential to understand that if the variability in the average consumption between household units is large, then the overall average computed for a small sample of units may be very sensitive to the particular units selected for the sample. Therefore, the larger the variability in consumption patterns across dwelling units, the larger the number of units that need to be included in the data set to get a reliable or statistically valid overall average. Conversely, because this valid sample size is directly proportional to variance, if the variance of a data set can be reduced, the sample size that is required can be decreased as well.

Variance in utility consumption patterns across dwelling units can be the result of a variety of causes, and how to deal with the variability depends on its source. For example, if variability in the data is due to differences in ***family size*** or differences in the ***physical condition of the units***, then the most appropriate approach is to construct separate allowance categories according to these factors (see discussion in Step #3, above).

Other significant sources of variability are vacancies and non-allowable end-uses. Variability due to these sources should be addressed as described in the section on data cleaning, either through deleting the units from the sample or by just dropping the months or quarters in which these factors appeared, keeping the dwelling unit(s) in the sample for the other time periods during which the reading were valid. Under the first approach, it becomes a tradeoff of reduced variability *versus* a smaller number of units left in the sample with which to achieve statistical validity.

For larger HAs, or larger allowance categories in any sized HA, there are more options regarding approaches to sampling to reduce unrepresentative variance. For example, after having "cleaned" the data for vacancies, ineligible end-uses and the like, the HA can then drop out the top 10 percent and bottom 10 percent of the units based on consumption levels. The resulting sample will have less variability because the extreme values have been dropped.

Once the HA has done what it can to reduce the unrepresentative variability in the sample for an allowance category, then the remaining variance must be calculated to determine whether the sample size is sufficient to ensure statistical validity. When the variance has been calculated,[4] the figure for variance can be plugged into the earlier formula for valid sample size to determine how many units need to be included from the allowance category.

If the planned sample size is smaller than the size recommended by this calculation, then the HA should include data from more units. If additional units are not available from the allowable category, the HA should consider combining similar allowance categories (e.g., combine studio and one-bedroom units) to create a new allowance category with a larger sample size. The critical issue, of course, is finding allowance categories that are reasonably comparable, so that units with significantly dissimilar consumption requirements are not lumped together. If the sample sizes for an allowance category are too small to satisfy the test of statistical validity, and the HA cannot identify categories that are similar enough to combine, then the HA should reconsider its use of the consumption methodology.

When ***checkmeters*** are utilized, the HA is more likely to have access to data on 100% of the units in any allowance category. Such HAs can use 100% samples, and this eliminates the need to check for statistical validity.

When residents pay directly to a utility, however, it may be much more difficult for the HA to obtain complete data for a sufficient number of units to ensure the statistical validity of the samples used for its allowance categories. In such cases, the HA should consider using the engineering methodology instead (see Chapter 5).

[4] In the example at the end of this chapter showing the allowance calculations for the fictitious Elm Street Apartments development, the complete formula for computing variance is presented in an illustrative application. Although the formula for variance may appear somewhat complex, most software spreadsheets and many scientific calculators have a function which performs this calculation. Again, if the HA uses a 100% sample of units from an allowance category, these calculations are not necessary.

Step #6: Determining the Point of Central Tendency for Each Data Set

Once the statistical validity of the sample for an allowance category is verified, the next step is to determine the "typical" consumption of a given monthly, bi-monthly, quarterly, or (in the case of non-checkmetered oil or propane) annual data set. The ***point of central tendency*** is the number that represents the typical or average consumption for a data set. There are two basic measures of central tendency: the median and the mean. The HA can choose to use either the mean or the median to represent the typical consumption within an allowance category.

Mean. The ***mean*** is, technically speaking, the average of a data set. The mean of a data set is determined by adding up all the records or values in the data set and dividing the total by the number of records in the data set. The mean is an appropriate measure of central tendency when the data are normally distributed and not skewed toward either extreme.

Median. The ***median*** is the point in a data set that is found in the middle of all the records, that is, exactly half the values of the records are higher than the median and half the values of the records are lower. The median may be the most appropriate point of central tendency if the data set contains extremely high or low consumption levels.[5]

After the HA has selected the mean or the median as its measure of central tendency for its calculation for each ***allowance category***, the HA should calculate one "average" consumption amount across all units in the sample for ***each*** of 12 monthly data sets, six bi-monthly data sets, or four quarterly data sets that have been collected. (In the case of non-checkmetered propane or oil, each allowance category should have ***one*** average value, based on an annual data set.) Next, where averages are for periods other than monthly, these averages should be converted to monthly amounts:

- If the averages are based on ***bi-monthly*** data sets, each bi-monthly average should be broken down into two monthly averages by dividing the bi-monthly average by two.

- If the averages are based on ***quarterly*** data sets, each quarterly average should be broken down into three monthly averages by dividing the quarterly average by three.

[5] Ferrey, Steven, "In From the Cold: Energy Efficiency and the Reform of HUD's Utility Allowance System," *Harvard Journal on Legislation*, vol. 32, no. 1, Winter 1995, pp. 187-188.

- If the averages are based on ***annual*** data sets, as is the case with non-checkmetered propane or oil, each annual average should be broken down into 12 equal monthly averages by dividing it by 12.

Adjusting for Non-Allowable End-Uses

Once the point of central tendency (the "typical consumption") is determined for each data set, that level of consumption should be adjusted for any end-uses that the HA considers non-allowable end-uses, if such consumption has not already been deleted from the data. Air conditioning is an example of an end-use that many HAs will determine to be non-allowable for some or all of their units. HAs that do not have any non-allowable end-uses may wish to skip this section.

To adjust the mean or median for non-allowable end-uses, the HA needs to have a fairly accurate idea of the percentage of households in each allowance category that have the non-allowable end-use. In addition, the HA should also have some idea about the energy rating of the appliances involved (for example, the wattage), as well as an estimate of how many hours the appliances are used per day. Much of this information can be obtained by inspecting the apartments. If the HA is large, a representative sample of apartments can be inspected. Alternatively, the HA can issue surveys to the residents.

The mean or median cannot be adjusted for non-allowable end-uses unless the following information is available:

- *the percentage of households within an allowance category that have the non-allowable end-use;*
- *the average energy rating of the appliances; and*
- *an estimate of how many hours the appliances are used.*

With this information, the HA can estimate the amount of energy the non-allowable end-use consumes every month. This can be done in one of two ways:

Method #1: Using mathematics. If the non-allowable end-use is electric, then the monthly consumption amount may be estimated as follows:

(a) multiply the average wattage of the non-allowable appliance by the hours in use per day to get watt-hours per day;

(b) multiply the watt-hours per day by 31 days to get watt-hours per month;
(c) divide the watt-hours per month by 1000 to get kilowatt-hours (kWh) per month.

The following table provides consumption information for air conditioners. These consumption amounts were determined using the process described above.

Monthly Electric Consumption Requirements for a Typical Air Conditioner[6]

	3 hours/day	6 hours/day
Energy-efficient (500 Watts)	47 kWh	93 kWh
Average efficiency (670 Watts)	62 kWh	125 kWh

Method #2: Using standard consumption tables. The HA could also use standard consumption tables to determine the monthly consumption requirement of a given non-allowable end-use.

These tables usually depict average ***annual*** consumption, rather than monthly, and the amounts must be adjusted accordingly.

Furthermore, if standard consumption tables are used, the HA should make sure the assumptions in the table are consistent with the information the HA has on hours of usage and energy ratings.

Once the HA determines the amount of energy the non-allowable appliance uses per month, the following process should be followed to determine the amount by which the mean or median should be adjusted for such non-allowable end-uses:

(A) For each allowance category that includes dwelling units that have the non-allowable end-use, multiply the consumption amount attributable to the non-allowable end-use by the percentage of dwelling units in the allowance category that have the non-allowable end-use; then

(B) Subtract the amount obtained in Step (A) from the point of central tendency (mean or median) for each allowance category. ***For seasonal non-allowable end-uses, this amount should be***

[6] The hours of usage depend on the regional climate. The typical wattage of an air conditioner is 670 Watts (Edison Electric Institute).

subtracted only in those months that the appliance is normally used.

Optional Approach: Normalizing for the Effects of Weather

As indicated in the beginning of this chapter, an alternative to establishing allowances based on a three-year rolling database is to establish allowances based on one or more years' worth of consumption data that have been normalized for weather, based on 30-year averages. This approach is only appropriate for utilities used for ***heating***.

If allowances are based on "normalized" consumption data, the HA does not need to obtain new consumption data every year. This approach may be especially attractive for HAs that have individually metered utilities.

Normalizing the data requires the following information:

- **One or more years' worth of consumption data.** Data from at least one year are required. If the HA has not obtained actual consumption data in the last two years, then the HA should obtain more recent data. If the HA has been using a three-year rolling database, then this database may be used as well for this alternative approach. By doing so, the HA can simplify what needs to be done annually as part of the review of allowances.

- **Total heating degree days.** This information must be obtained ***for the year or years from which the consumption data were taken***. This information may be obtained from a local weather station. In many cases, the local utility also has this information. These data should be from the same weather station as the 30-year average degree days used in this process (see below).

- **Thirty-year average annual heating degree days.** The 30-year average annual degree days should be from the same weather station as the degree days for the year in which the consumption data were recorded. ***Appendix C provides 30-year average annual degree days for several weather stations in each state.***

- **Thirty-year average monthly heating degree days.** Thirty-year average ***monthly*** degree days are required only for ***checkmetered utilities***, or for ***individually metered utilities for which the HA provides seasonally adjusted allowances***. The 30-year average monthly degree days should be from the same

weather station as the degree days for the year in which the consumption data were recorded. ***Appendix C provides 30-year average monthly degree days for several weather stations in each state.***

An example of normalization is presented later in this chapter.

STEP #7: Establish Standards for the "Energy-Conservative Household"

After having calculated the "typical" consumption level for a utility, the HA is still faced with the choice of the standard for consumption that it will establish for an "energy-conservative household."

It is logical to assume that a sizable percentage of resident households will have consumption levels above the "point of central tendency" (the average). Therefore, the HA must decide to what extent the utility use above the calculated average represents wasteful consumption which was within the ability of the residents to control.

For example, it would be difficult to justify the statement that a two-bedroom household using a single kWh per month more than the average for that category of units was actually "wasting" electricity (except in the instance where the average itself was found to be exceptionally high). Unless there is strong evidence to the contrary (e.g., see next section on comparison with engineering-based allowances), the HA probably should assume that most of its lower income residents engage in reasonably energy-conservative behavior. Consequently, if a large percentage of resident households have consumption above the average and the HA has made diligent efforts to provide conservation education, then it is generally proper to conclude that much of the consumption above the average was not within the power of the residents to control. In such circumstances, the HA should provide a range above the average consumption that will still be considered non-excessive.

There are a variety of ways for the HA to establish such a range. One way is to set the consumption allowance at the level of the ***mean plus one standard deviation***. The standard deviation, which is the square root of the variance, provides a measure of the typical variation in consumption by dwelling units within a category from the average consumption for that category. By adding the standard deviation to the mean, the HA would ensure that the consumption of most residents households would fall within the allowance standard.

A second approach to determining an acceptable range above the average is to divide the dwelling unit consumption data into ***percentiles***, and then selecting the level (e.g., the 85th percentile) above which the HA feels

that consumption is clearly excessive based on its familiarity with utility use patterns across the agency over time.

A third alternative, particularly for HAs desiring to limit the complexity of their calculations, is to simply ***multiply the average by a coefficient greater than 1.0*** to provide for a fixed percentage of consumption above the average which will be considered permissible. For example, if the coefficient 1.25 is used, the allowance level permits consumption 25 percent above the average without a surcharge being incurred by the resident household.

Option: Comparing With Consumption Levels Derived from Engineering Method

For those HAs with the capacity, an excellent approach for checking the reasonableness of the allowance levels derived from the consumption-based methodology is to check them against the comparable levels that the engineering-based method would suggest.

Since the engineering method emphasizes theoretical norms for utility use rather than actual past consumption experience, it can be expected that the allowance levels suggested by this alternative methodology will be somewhat different from those derived under the consumption-based method. However, by comparing the average consumption calculated under the consumption-based method with what the engineering method suggests the typical consumption should be, the HA will be able to make a better judgment about whether a range above the average is appropriate in setting the standard for an "energy-conservative household," and how large that range should be.

Step #8: Converting Consumption Allowances to Dollar Allowances

For each allowance category, each of the 12 monthly consumption amounts established as a result of Step #7 should be converted into a dollar amount.

Electricity. Consumption amounts of electricity are in kWh. The kWh amounts are converted to dollar amounts by multiplying the kWh by the utility rate, which is the price per kWh, and adding the base charge or customer charge and any other charges levied by the utility. Some utilities charge one rate for usage up to a certain level and another rate for usage beyond this level. If the utility has seasonal rates, the HA should multiply the consumption amounts by the rate appropriate to that particular season. For example, if the utility has one rate for September through May, and another rate for June through August, then the consumption amounts in June, July, and August should be multiplied by the summer rate, and the consumption amounts in the other months should be multiplied by the off-season rate.

Gas. Consumption amounts for gas are in hundred cubic feet (ccf) or therms. The consumption amounts for gas in terms of ccf or therms are converted to dollar amounts by multiplying them by the price per ccf or therm and adding any customer charges or adjustments. As with electricity, if the gas company has seasonal rates, these rates should be used.

Water. Consumption amounts for water are usually in ccf or gallons. The consumption amounts for water in terms of ccf or gallons are converted to dollar amounts by multiplying them by the price per ccf or gallon.

In many areas, there is an additional charge for sewer service. If the sewer charge is a rate charged per ccf or gallon, then this fee should be multiplied by the ccf or gallons, and added to the dollar amount for water. Where the sewer rates vary seasonally, the rate appropriate for each month should be used.

Where water is individually metered, if a monthly flat fee is charged, this amount should be added to the dollar allowance.

Propane or Oil. Consumption amounts for propane and oil are in gallons. The consumption amounts for propane or oil in terms of gallons are converted to dollar amounts by multiplying the consumption amounts by the average price per gallon of propane or oil.

Individually Metered Utilities: Establishing Equal Monthly Allowances

HAs with individually metered utilities generally provide ***equal monthly allowances*** for those utilities. (However, if the utility supplier does not offer residents a uniform payment plan, the HA may provide for seasonal variations in its allowances.) Where equal monthly allowances are to be provided, the monthly dollar allowances calculated for each allowance category should be added together to get an annual dollar amount for each allowance category. This amount should then be divided by 12 to get equal monthly allowances.

STEP #9: Publish Allowances with Opportunity for Resident Comment

As indicated in Chapter 2, the HA must not only maintain a record which documents the basis upon which the utility allowances were established, but also must give notice to ***all*** residents of proposed allowances or revisions to allowances at least 60 days prior to the date the allowances are to become effective. (The exceptions to this rule are when changes in allowances or the dollar amount of surcharges are directly due to changes in the HA's average utility rate; such rate changes are not subject

to the 60-day notice requirement. See 24 CFR 965.506(a).

The notice to residents must include a description of the method for calculating the allowances, the specifics on where residents can obtain access to full documentation of the allowance methodology and calculations, notification of the residents' right to submit written comments, and information on the availability of individual relief for residents with special circumstances or needs.

A Final Note: Energy-Conservation Outreach and Support to Residents

HAs should recognize the importance of an on-going energy-conservation education effort, particularly aimed at residents whose consumption exceeds their allowance. Such outreach and education efforts that result in more energy-conservation by residents will not only benefit the individual households experiencing surcharges, but will also tend to reduce the HA's overall utility use and costs.

In addition, the HA should remain alert to weatherization measures and equipment upgrading which the agency could undertake that would reduce resident utility consumption.

THE APPLICATION OF THE CONSUMPTION-BASED METHODOLOGY: EXAMPLES

This section of Chapter 6 illustrates each step of the consumption-based methodology by guiding the reader through a series of examples involving a fictitious housing development, ***Elm Street Apartments***. The section demonstrates how to follow the steps to generate the consumption allowances for a single allowance category (three-bedroom units on the top floor) and explains how the process would differ for determining the consumption allowance for other allowance categories and utilities.

Elm Street Apartments, a fictitious site located in a moderate climate, is a 96-unit family development consisting of four three-story buildings containing 24 units apiece. Each building has the following configuration:

2 2-BR Top End	2 3-BR Top Middle	2 4-BR Top Middle	2 2-BR Top End
2 2-BR Middle End	2 3-BR Middle Middle	2 4-BR Middle Middle	2 2-BR Middle End
2 2-BR Bottom End	2 3-BR Bottom Middle	2 4-BR Bottom Middle	2 2-BR Bottom End

All four buildings are of identical design and construction, and are in essentially the same physical condition. All the buildings have gas heat, hot water, and cooking. Refrigeration, lighting, and appliances are electric. The apartments have hook-ups for electric clothes washers and dryers. Gas, electricity and water are checkmetered. The HA provides trash pick-up services, which are non-metered.

We will now proceed through each of the steps in the consumption-based methodology.

Step #1: Specifying the Allowable and Non-Allowable End Uses

In determining which end-uses should be included in the allowances, the HA takes into account two items: (1) the metering configuration of the utilities, and (2) whether there are any end-uses which it considers non-allowable.

Metering configuration: Because gas, electricity and water are checkmetered at Elm Street Apartments, allowances are provided for all three of these utilities.

Because the HA provides the trash pick-up and this utility is not metered, the HA assumes all the costs for this service and no separate allowance is established for it.

Non-allowable end-uses: Although the HA permits air conditioning as an allowable end-use in its elderly developments, in the family developments air conditioning is a non-allowable end-use. However, the HA does permit cooling fans in the family developments.

Therefore, the following end-uses are allowable for the family units, and allowances must be established for each category of utilities identified:

Gas

- space heating
- domestic hot water
- cooking

Electricity

- refrigeration
- lighting
- appliances (including washer/dryers and ceiling fans)

Water/sewer

Step #2: Determining the time frame for historical consumption data

In deciding between a ***three-year rolling base*** of consumption data and a ***fixed data base normalized for weather***, there are a number of considerations. The three-year rolling base requires data collection and allowance recalculations every year; the annual data collection may be a particular problem if the HA must go to the utility for such records (after obtaining permission from the residents). The fixed data base approach avoids these annual data collection and recalculation functions, but to use this approach the HA must have good data on 30-year weather averages for the locality and perform somewhat more complex calculations.

Because Elm Street Apartments is checkmetered, the HA does not need to worry about the problem of obtaining consumption records from utility companies. Therefore, for this example, the three-year rolling base will be used. However, Step #6 will demonstrate how the data could be normalized for 30-year weather averages.

Step #3: Selecting the proper allowance categories

In developing allowance categories, the HA needs to consider all the factors specified in the federal requirements (see Chapter 2) that might make a difference in the consumption requirements among units. Then the HA should classify the dwelling units into separate groupings according to the characteristics which can be expected to significantly affect consumption requirements.

In looking at Elm Street Apartments, it can be seen that all the units will have certain characteristics in common, including:

- **the local climate**
- **equipment and functions to be covered by the allowances**

- **construction and design of the housing development**
- **energy-efficiency of HA-supplied appliances and equipment**
- **physical condition of the development**
- **indoor temperature**

Therefore, the allowance categories for each utility do not need to make distinctions among units according to these factors.

However, there are several factors affecting consumption where the characteristics of the Elm Street Apartments units vary among each other. These include:

- **dwelling unit size/number of occupants**
- **location of unit within the building (for space heat and cooling)**

Accordingly, these factors should be used as the criteria for developing separate allowance categories. Applying these factors, ***the following six allowance categories are generated for Elm Street Apartments:***

2-BR Top End Units (16 units)
2-BR Middle End and 2-BR Bottom End Units (32 units)
3-BR Top Middle Units (8 units)
3-BR Middle/Middle and 3-BR Bottom Middle Units (16 units)
4-BR Top Middle Units (8 units)
4-BR Middle/Middle and 4-BR Bottom Middle Units (16 units)

The remainder of this illustrative application of the consumption-based methodology will focus on the third allowance category -- 3-bedroom units on the top floor.

Step #4: Collecting the data and grouping by allowance categories

Since gas, electricity and water/sewer are checkmetered at Elm Street Apartments, and the checkmeter readings are routinely recorded every quarter, the data needed for the three-year rolling base are readily available. The following table presents how data on ***gas consumption*** might be organized for the 3-bedroom top floor units at Elm Street Apartments; note that this consumption is related to three end-uses -- space heating, domestic hot water and cooking.

Elm Street Apartments
Allowance Category: 3-BR Top Floor
Quarterly Natural Gas Consumption (Measured in Therms)

Year	Unit	Jan - Mar	Apr - Jun	Jul - Sep	Oct - Dec	Monthly Average
1992	A-18	260	73	49	197	49
	A-23	284	79	54	214	53
	B-18	218	61	41	165	40
	B-23	392	109	74	296	73
	C-18	263	85	46	199	49
	C-23	241	70	55	201	47
	D-18	310	90	61	230	58
	D-23	275	89	47	188	50
1993	A-18	256	65	48	199	47
	A-23	292	83	50	201	52
	B-18	200	63	44	171	40
	B-23	378	111	*23*	290	67
	C-18	268	79	41	187	48
	C-23	251	75	60	214	50
	D-18	289	78	59	213	53
	D-23	268	83	46	192	49
1994	A-18	240	66	45	183	45
	A-23	269	80	54	211	51
	B-18	207	59	45	185	41
	B-23	351	102	71	299	69
	C-18	271	81	43	173	47
	C-23	*163*	77	63	220	44
	D-18	294	82	62	218	55
	D-23	260	78	50	188	48

The seasonal variation in consumption levels is a reflection that most of the consumption for space heat is limited to the period of January through March and October through December.

Similar tables can be constructed for ***electricity*** and ***water/sewer*** utility consumption using the checkmeter records.

Step #5: Cleaning the data and checking for statistical validity

Example of data cleaning

Problems in the quality of consumption data can occur as a result of a number of factors, including ***estimated or missing readings***, ***vacancies***, ***non-allowable end uses***, and ***inaccurate meters***.

In the example of natural gas consumption for the 3-bedroom top floor units shown in the preceding table, the data are relatively complete and "clean," with no missing or estimated readings. The HA staff responsible for Elm Street Apartments also annually compare their total of checkmeter readings against mastermeter readings for accuracy, and have found the former to be within 1 percent of the latter. There are also no non-allowable end-uses. (Note: As part of the discussion of Step #6, an example of adjustment for non-allowable end-uses will be presented.)

In this illustration, however, there are two examples of ***vacancies*** in the table: Unit B-23 was vacant for almost 2 months during the period of July - September 1993, and Unit C-23 was vacant for a month in the period of January - March 1994.

One option for "cleaning" the data is to delete these two units from the sample. However, based on the "rough rule of thumb" for valid sample sizes noted earlier in this chapter, the remaining 6 units would leave the HA at the very lower limit of an acceptable sample size. Therefore, the HA should try to adjust for these vacancies to permit the inclusion of these units in a sample. By retaining these units through careful data cleaning, the HA can achieve a 100 percent sample.

There are several ways to adjust the data for these two vacancies to come up with an approximation of what the consumption would have been if the units had been occupied for the entire period. First, since the HA has three years of data, and assuming the residents in the units have not changed, the HA can simply substitute the consumption for that unit from the same 3-month period in another year. For example, for Unit B-23, the HA could replace the July - September 1993 figure (***23 therms***) with the figure from July - September 1992 (***74 therms***).

A second approach to data cleaning for the vacancies would be to take the consumption level shown for the calendar quarter in question, and extrapolate this figure to cover the entire 3-month period. For example, Unit C-23 consumed ***163 therms*** during two months' of occupancy in the first quarter of 1994; by multiplying this figure by 3/2 the HA can get an approximation of what the consumption would have been (***245 therms***) had the unit been occupied over the entire three-month period.

If the utility being examined generally exhibited little seasonal variation in consumption, the HA could also consider simply dropping the period with the vacancy, and calculate the average consumption based on the remaining months.

In any particular instance of data cleaning, the HA will need to make a judgment about which of the available approaches is likely to result in the best estimate, given the other data which is available and the HA's familiarity with its residents and historic patterns of consumption.

Example of assessing the statistical validity of the sample size

It has been noted that the ideal approach to ensuring statistical validity is to use a 100 percent sample, particularly for smaller allowance categories. However, there may be numerous instances where an HA does not have the data or desire to achieve a 100 percent sample; how can the HA determine that the sample which it is planning to use is large enough to be statistically valid?

In such cases, the HA can use the formula for valid sample sizes presented earlier in this chapter.

Assume that the standard for statistical validity that must be met is there must be a ***95 percent probability*** that the average from the sample is ***within 10 percent*** of the true average for the allowance category. To determine how large a sample is needed to meet this standard, the following formula would be used:

$$\text{valid sample size} = \frac{3.84 * Var}{(0.10 * Avg)^2}$$

where *Var* stands for ***variance*** and *Avg* stands for the ***average monthly consumption*** across the dwelling units in the sample.

For present purposes, the ***variance*** is a measure of the extent to which the values of the annual average consumption of the ***individual dwelling units*** in the sample differs from the average consumption computed ***for the overall sample***.

The variance should be calculated across units using the annual periodic average for each unit. Using the following table layout, the variance would be calculated for the last column of annual periodic (monthly) averages.

Elm Street Apartments: 2-BR Middle and Bottom Units
Consumption of electricity (kWh)

Year	Unit	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Monthly Average for Year
1994	A-7													
	A-9													
	B-7													
	B-9													
	Etc.													
	Etc.													

Most spreadsheets and scientific calculators have a function that calculates variance. The formula for sample variance is:

$$Var(x) = \frac{(x_1 - Avg)^2 + \ldots + (x_N - Avg)^2}{(N-1)}$$

$$Avg = \frac{x_1 + \ldots + x_N}{N}$$

where N equals the number of dwelling units in the sample for which there is an annual periodic average, and where x_1 through x_n represent the individual annual periodic averages for the individual dwelling units (i.e., the last column of the table). The variance for the sample is the sum of the squared differences between each value and the average value divided by N-1.

Suppose the variance of the sample calculated using this formula is 225 and the mean (average) of the annual monthly averages is 65kWh. By plugging these numbers into the earlier formula for sample size, it is determined that the sample size needs to be at least 20 units (that is, $(3.84*225)/6.5^2 = 20.4$) to achieve the statistical precision sought. This means that with sample of 20 units that has a mean of 65kWh and a variance of 225, there is a 95 percent probability that the sample mean is within 10 percent (or 6.5) of the true mean.

If the current sample size is smaller than the size recommended by the formula to achieve statistical validity, the HA has three options:

1) Increase sample size by including more units from the allowance category;

2) Combine similar allowance categories to create a new category where there is a sufficiently large sample to achieve validity; or

3) Shift to the engineering-based methodology.

Step #6: Determine typical consumption for the allowance categories

Once the data have been cleaned and the statistical validity has been verified, the next step is to determine the ***point of central tendency*** -- the number which represents the "typical" consumption of a given monthly, bi-monthly, quarterly, or (in the case of non-checkmetered oil or propane) annual data set.

In the example of gas consumption for the three-bedroom top floor units at Elm Street Apartments (***see table for Step #4***), assume that the HA opts to use the ***mean*** (average) as the point of central tendency. To find the mean, the column for each calendar quarter is totalled and divided by 24, which is the

number of separate records in each column. The result is the typical consumption for each month, as follows:

Elm Street Apartments: 3-BR Top Floor
Mean Natural Gas Consumption (in Therms)

Jan - Mar	Apr - Jun	Jul - Sep	Oct - Dec
274	80	58	210

Note: Consistent with the earlier discussion of data cleaning, for the Unit B-23 vacancy during July through September 1993 the figure 23 has been replaced with 74, and for the Unit C-23 vacancy during January through March 1994, the figure 163 has been replaced with 245.

Example of using fixed data base normalized for weather

The example of natural gas consumption has assumed the use of a three-year "rolling base" of consumption data, which means that every year consumption data from the most recent year are added to the sample and data from the earliest year in the previous set of three years are deleted.

Another option for calculating allowances for space heating end-uses, however, is to use a fixed data base normalized for weather using 30-year averages. This approach has the advantage that the database does not need to be updated every year.

To develop allowances based on the 30-year averages, the HA first completes Steps #1 through Step #6 described above. Then the HA must:

(1) Annualize the mean or median for each allowance category by adding together the 12 monthly figures, or 4 quarterly figures, etc.

(2) If consumption data from more than one year are used, then the heating degree days (HDD) from those years should be averaged. This is done by adding the HDD from those years and dividing the total by the number of years worth of data used. This average of HDD from the years in which the consumption data were taken is used in (3). If consumption data from just one year are used, then the HDD from that year is used in (3).

(3) For each allowance category, divide the annualized mean or median by the number of HDD from (2).

(4) For each allowance category, take the answer from (3) and multiply it by the ***30-year average annual*** HDD. This amount is the ***normalized annual consumption***.

The next two steps are only for checkmetered utilities, or for individually metered utilities where allowances provide for seasonal variation. (These steps should not be completed for utilities that are individually metered if the allowances do not provide for seasonal variation).

(5) For each month, divide the 30-year average HDD for ***that month*** by the 30-year average ***annual*** HDD. These calculations will yield the percent of annual heating demand for each month.

(6) For each month, multiply the percentage by the normalized annual consumption. These calculations will yield the ***monthly normalized consumption*** requirements for that utility.

To illustrate the weather-normalization approach, imagine a second fictitious housing development, ***Lincoln Apartments***, which has five buildings that use gas for space heating and cooking. In the case of Lincoln Apartments, the HA performs checkmeter readings every month. For this development, we shall normalize the space heating consumption for the allowance category of one-bedroom end apartments on the top floor.

The monthly means for a valid sample of the selected allowance category are:

Lincoln Apartments
Allowance Category: 1-BR End Top
Mean Monthly Space Heating Consumption in 1994 (in Therms)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
114	87	61	22	10	0	0	0	6	20	63	96

Following the directions described above, first, these monthly means are annualized by adding them together, to get an annual average of: ***479 therms***.

Next, since only one year of data is being looked at, only the figure for total heating degree days for 1994 is needed; this information is obtained from the local weather station: ***4,433 HDD Total***. The figure for the annual mean is then divided by this number: ***0.108***.

The result of the above is then multiplied by the 30-year average annual HDD (***4,940***) to get the ***normalized annual consumption: 533 therms***.

Since the utility is checkmetered, the following calculations are performed to get the ***monthly normalized consumption***:

Lincoln Apartments
Allowance Category: 1-BR End Top
Monthly Normalized Space Heating Consumption (in Therms)

Month	30-Year Average Monthly HDD	Divided by 30-Year Average Annual HDD	= Percent of Annual Heating Demand	x Annual Consumption (Normalized)	= Monthly Normalized Consumption
January	1,023	4,940	21%	533	112
February	879	4,940	17%	533	90
March	725	4,940	14%	533	75
April	381	4,940	8%	533	43
May	128	4,940	3%	533	16
June	0	4,940	0	533	0
July	0	4,940	0	533	0
August	0	4,940	0	533	0
September	32	4,940	1%	533	5
October	254	4,940	5%	533	27
November	579	4,940	12%	533	64
December	939	4,940	19%	533	101

Example of adjusting for non-allowable end-uses

Elm Street Apartments is in a region of moderate climate. The HA considers air conditioning to be a luxury, and a non-allowable end-use.

Through inspections of the dwelling units, the HA estimates that 20 percent of the households in all allowance categories have functional air conditioners. The HA estimates that these air conditioners are of average efficiency and that they run an average of 3 hours per day during the months of June, July and August.

Based on industry data (see Appendix C), the HA calculates 62 kWh as the typical monthly electric consumption for air conditioning. The 62 kWh is then multiplied by 20 percent, which equals 12.4 kWh. This amount, 12.4 kWh, is then subtracted from the central tendency for the "typical" consumption which was calculated for the months of June, July and August. This adjustment removes the non-allowable end-use from the consumption allowance figures.

Step #7: Establish standards for the "energy-conservative household"

This is probably the most challenging step in using the consumption-based methodology: ***an HA will want to create a consumption standard which not only encourages conservation, but also is set at a level which clearly is within the ability of residents to achieve.***

Finding the "point of central tendency", whether using the mean or the median, in many cases is only the starting point. For example, looking at the natural gas consumption table for Elm Street Apartments in Step #4, it is seen that if the average consumption of 210 therms per unit for the period of October - December had been used as the consumption standard during the three-year period, in any single year between 38 percent and 50 percent of the households in the allowance category would have paid a surcharge. Under such circumstances an HA must seriously examine whether it believes that such a high percentage of its residents are actually engaging in "excessive consumption" that is within their ability to reduce.

One approach to get another perspective on standards for reasonable allowances is to ***look at the corresponding consumption levels which the engineering-based approach would suggest.*** It is not necessary for an HA to complete a full engineering analysis to accomplish this. For example, the HA could consult with other public housing agencies in their region (with similar development and resident characteristics) that use the engineering method; through such consultations, the HA should be able to get an initial sense of the comparable allowances that are generated by the engineering approach, and whether further exploration of engineering data would be productive. The HA could also decide to perform the engineering calculations only for the specific end-uses about which the agency has the most questions concerning the consumption data.

Because of the fundamental differences in the approach used, it is to be expected that the engineering method will frequently suggest allowance levels that vary from those generated by the consumption method. This should not be viewed as a problem, but instead as an opportunity for the HA, by comparing the two methods, to better understand the consumption patterns of its residents.

Unless engineering or other data strongly suggest otherwise, it is recommended that the HA assume that most resident households engage in reasonably energy-conservative behavior. It appears to be plausible to assume that, given their limited financial resources, the majority of public housing resident households would not engage in wasteful consumption that would result in a surcharge for any utilities within their control. Therefore, the HA should consider establishing a range above the point of central tendency that reflects this view.

Assume that for Elm Street Apartments, the HA has decided to establish its consumption allowance standards based on ***the mean plus the standard deviation*** (the latter is the square root of the variance). For the example of natural gas consumption, across the three years of data, ***the mean consumption of the allowance category for the fourth quarter of the calendar year was 210 therms, with a standard deviation of 36, which would result in a consumption allowance of 246 therms for this period.*** With this allowance, only 13 percent of the resident households from this allowance category would be assessed a surcharge for the fourth quarter of the calendar year.

There are other approaches which can be used to establish a fixed range above the point of central tendency as the allowance standard. The HA could decide to set its allowances at 25 percent above the mean; this would simply involve ***multiplying the mean by a coefficient*** (1.25).

The HA may alternatively decide to establish the consumption allowance standard based on ***percentiles***; for example, setting the allowance equal to the 85th percentile of past consumption across the sample for any allowance category.

Step #8: Convert the consumption allowances to dollar allowances

At this point, the HA has determined the monthly consumption allowances for the utility (in the example, gas consumption). The HA must then convert the consumption allowances for each utility by multiplying the consumption allowance by the applicable rate for each part of the year.

Example: The consumption allowance was established at the level of the mean plus one standard deviation. The current gas rate is $0.65/therm for October through March, and $0.55 for April through September.

Elm Street Apartments
Allowance category: 3-BR Top End
Gas Allowances

	Jan - Mar	Apr - Jun	Jul - Sep	Oct - Dec
Consumption Allowance (therms)	320	93	68	246
x Rate ($/therm)	.65	.55	.55	.65
Dollar Allowance ($)	$208	$51	$37	$160

If the HA wanted to implement the schedule of allowances and surcharges on a monthly basis, it would simply divide each of the dollar allowance figures by 3 to provide even monthly amounts within each quarter.

Question & Answer Exercise for Chapter 6

Questions

1. **Which of the following statements is true if the three-year rolling base approach is used?**
   (a) Allowances must be recalculated every year.
   (b) The HA must obtain new data every year.
   (c) The allowances reflect gradual changes in consumption over time.
   (d) All of the above.

2. **Regarding the process of collecting consumption data, which of the following statements is *FALSE*?**

   (a) Utilities generally require that the HA present a release form that has been signed by the resident before it will release consumption information for that household.
   (b) For oil or propane that is not checkmetered, the HA should collect consumption data from the fuel company or the resident, and then annualize it.
   (c) When the HA compares the checkmetered consumption total to the master-metered consumption total, if the two amounts are not equal, the data should not be used.
   (d) If checkmeter readings have not been made at regular intervals, the data are of unacceptable quality.
   (e) None of the above.

3. **Which of the following may be acceptable measures of the typical consumption of a data set, assuming the data set is statistically valid?**

   (a) The point of central tendency.
   (b) The mean value.
   (c) The median value.
   (d) All of the above.

4. **Which of the following sources of information should be available when adjusting for non-allowable end-uses?**

   (a) The percentage of dwelling units that have the non-allowable end-use.
   (b) The average energy rating of the non-allowable appliance.
   (c) An estimate of the number of hours the appliance is typically used per day.
   (d) All of the above.

5. **If the weather-normalization approach is taken, where might the HA obtain weather data for the year in which the consumption data were taken?**

   (a) In the appendix of this guidebook.
   (b) From the local weather station.
   (c) From the local utility.
   (d) All of the above.
   (e) (b) and (c).

Question & Answer Exercise for Chapter 6

Answers

1. (d) All of the above. All of these statements are true of the three-year rolling-base approach.

2. (c). If the checkmetered total does not equal the master-metered total, the data may still be of acceptable quality. If the two amounts differ by 10 percent or more, however, then the data should not be used.

3. (d) All of the above. The typical consumption in a data set may be determined using the mean or median. Both the mean and median are points of central tendency.

4. (d) All of the above. The HA should have all of this information before adjusting for non-allowable end-uses.

5. (e). Weather data for a given year may be obtained from the local weather station, and in many cases, from the local utility. The appendix provides 30-year average monthly and annual data, but does not provide data for particular years.

CHAPTER 7: ANNUAL REVIEW OF ALLOWANCES

Overview

Each HA is required by the regulations to ***review its utility allowances on an annual basis*** to ensure that the allowances continue to be reasonable. There are two types of changes that can affect the reasonableness of the allowances from year to year: (1) changes in utility rates, and (2) changes in consumption requirements of a household. These two factors should be checked every year in the annual review process.

The extent of the review process depends on how the allowances were calculated in the first place. If the allowances were calculated using the engineering-based methodology or the "weather-normalization" approach of the consumption-based methodology, then the review process is relatively simple and straightforward. In these cases, the review does not normally involve a great deal of work, unless there is a change in equipment or building condition, the HA decides to use a new fixed database, or a problem is discovered in the method previously used.

On the other hand, if the allowances were established using the three-year rolling base approach of the consumption-based methodology, then the review process is actually a process of recalculating the allowances after collecting one new year of data.

This chapter offers step-by-step guidance on the annual review process for allowances calculated using any of these specified approaches.

If the Engineering-Based Methodology is Used

When the engineering-based methodology is used (see Chapter 5), the HA estimates the reasonable consumption of various categories of dwelling units, based on assumptions about the structure of the units, the appliances and equipment, and various other factors that affect consumption requirements. Whenever there are major changes to the buildings, equipment or appliances, the assumptions may no longer be valid, and the allowances should be recalculated based on new assumptions.

Even when there are not major changes to any of these factors from year to year, gradual changes occur over the years, affecting the consumption requirements of a household. Examples of these changes include the settling of insulation, possible declines in efficiency of equipment, and gradual changes in resident-owned appliances as societal customs and usage patterns evolve. Because of these gradual changes, the HA should

recalculate the allowances ***at least every five years*** to account for the effects of such changes on consumption requirements.

The annual review process for allowances calculated using the engineering-based methodology should therefore include the following steps:

Step #1: Since the time when the allowances were last calculated, review whether there have been any significant changes to buildings, equipment, or appliances that would affect the consumption requirements of the utility for which the allowance is provided. Examples of such changes include modernization or weatherization, replacement of the heating or hot water systems, or replacement of the refrigerators in a development. If there have been any significant changes that would affect the consumption requirements of dwelling units, then the allowance consumption amounts for the affected dwelling units should be recalculated.

Step #2: Check to see when the last time the allowance consumption amounts were recalculated. If the allowances have not been recalculated in the last five years, then they should be recalculated to take into account any changes over time that may have affected the consumption requirements of the dwelling units.

Step #3: Contact the local utility company to check the rates. If the rates have changed by 10 percent or more compared to the ones used when the allowances were calculated, then the regulations require the HA to recalculate the allowances based on the new rates.

If the Weather-Normalization Approach of the Consumption-Based Methodology is Used

When the weather normalization approach of the consumption-based methodology is used (see Chapter 6), the HA estimates the reasonable consumption of various categories of dwelling units based on a fixed set of consumption data from one or more years. It is generally acceptable to use data from only one year because these data are normalized for the effects of weather using 30-year averages. Normalizing the data for the effects of weather in this fashion "neutralizes" the data for weather effects, which can otherwise affect consumption requirements from year to year. When this approach is used, the HA does not have to obtain weather data every year (as it would have to do with the three-year rolling base approach).

Because new data are not obtained every year and integrated into the database, however, changes in consumption requirements over time are not reflected in the allowances. Consumption requirements may shift due to major alterations to the buildings, changes in equipment or appliances, or gradual changes occurring over the years (such as the settling of insulation and gradual changes in resident-owned appliances) that affect the utility consumption of a household.

Because the consumption requirements shift over time, a HA should recalculate the allowances whenever there are major changes to the buildings, equipment, or appliances. Even in the absence of major changes, the HA should recalculate the allowances every five years in order to account for gradual changes in consumption requirements.

The annual review process for allowances calculated using the weather normalization approach of the consumption-based methodology is the same as the review process for allowances calculated using the engineering-based methodology. The process should include the following steps:

Step #1: Since the time when the allowances were last calculated, review whether there have been any significant changes to buildings, equipment, or appliances that would affect the consumption requirements of the utility for which the allowance is provided. Examples of such changes include modernization or weatherization, the installation of heating or hot water systems, or replacement of a large portion of the refrigerators in a development. If there have been any significant changes that would affect the consumption requirements of dwelling units, then the allowance consumption amounts for the affected dwelling units should be recalculated.

Step #2: Check to see when the last time the allowance consumption amounts were recalculated. If the allowances have not been recalculated in the last five years, then they should be recalculated to take into account any changes over time that may have affected the consumption requirements of the dwelling units.

Step #3: Contact the local utility company to check the rates. If the rates have changed by 10 percent or more compared to the ones used when the allowances were calculated, then the regulations require the HA to recalculate the allowances based on the new rates.

If the Three-Year Rolling Base Approach of the Consumption-Based Methodology is Used

When the three-year rolling base approach of the consumption-based methodology is used (see Chapter 6), the HA estimates the reasonable consumption of various categories of dwelling units based on a set of three years of consumption data. This set of data is not fixed but changes ("rolls") every year, as data from the most recent year are added to the data set, and data from the oldest year are removed. By using a rolling database, gradual changes in consumption requirements over time are taken into account because the new data reflect these changes.[1]

This approach requires that new data be added to the database every year. Thus the annual review process for allowances calculated using a rolling base is actually a process of recalculating the allowances every year. The review process should include the following steps:

Step #1: Collect consumption data from the most recent year.

Step #2: Remove the oldest year's consumption data from the data set.

Step #3: Recalculate the allowances following the process described in Chapter 6.

In this chapter, we have discussed the process that a HA should follow in reviewing its utility allowances on an annual basis. The steps to be followed vary according to the utility allowance methodology that is being used. The amount of work that is entailed in these annual reviews also varies, not only according to the methodology used, but also based on the extent to which utility rates, the physical condition of the public housing units, the equipment or appliances involved, and/or the makeup of the resident population have changed. Conducting these annual reviews, however, is essential for maintaining appropriate utility allowance levels.

[1] Note that if recent modernization of developments has resulted in major, abrupt changes in consumption requirements, the HA probably should not be using the three-year rolling base approach (see Chapter 4).

Question & Answer Exercise for Chapter 7

Questions

1. **Regardless of how allowances were calculated in the first place, all HAs should do the following during the annual review process:**

   (a) examine current utility rates
   (b) obtain consumption data
   (c) interview households regarding consumption habits
   (d) perform a heat loss calculation
   (e) all of the above

2. **If allowances were calculated using the engineering-based methodology or the weather-normalization approach of the consumption-based methodology, allowances should be recalculated when the annual review process reveals that:**

   (a) some buildings were modernized since the allowances were last calculated
   (b) refrigerators were replaced in a large percentage of the dwelling units of one or more developments since the allowances were last calculated
   (c) new heating systems were installed at one of the developments since the allowances were calculated
   (d) it has been five years since the allowances were calculated
   (e) all of the above

3. *TRUE OR FALSE:* **If allowances were calculated using the weather-normalization approach of the consumption-based methodology, then the annual review process is actually a process of recalculating the allowances.**

4. **If the allowances were calculated using the three-year rolling base approach of the consumption-based methodology, allowances should be recalculated:**

   (a) when refrigerators were replaced at one of the developments
   (b) when some buildings were modernized
   (c) when new hot water systems were installed at a development
   (d) when the winter was especially harsh
   (e) every year, using the most recent year's consumption data

Question & Answer Exercise for Chapter 7

Answers

1. (a) examine current utility rates. Regardless of the approach used to calculate the allowances in the first place, all HAs should check with their local utility to see if rates changed from the previous year.

2. (e) all of the above. If allowances were calculated using the engineering-based methodology or the weather-normalization approach of the consumption-based methodology, allowances should be recalculated when the annual review process reveals any of these situations.

3. ***FALSE.*** If allowances were calculated using the ***three-year rolling base*** approach of the consumption-based methodology, then the annual review process is actually a process of recalculating the allowances.

4. (e) every year. If the allowances were calculated using the three-year rolling base approach of the consumption-based methodology, allowances should be recalculated every year using the most recent year's consumption data.