ORIGINAL

BEFORE THE FLORIDA PUBLIC SERVICE COMMISSION

DOCKET NO: 981591_EG

PREPARED REBUTTAL TESTIMONY AND

EXHIBIT OF TED S. SPANGENBERG,JR.

AUGUST 26, 1999

GULF POWER COMPANY

Before the Florida Public Service Commission
Rebuttal Testimony of
T. S. Spangenberg, Jr.
Docket No. 981591-EG
Date of Filing: August 26, 1999

Q. Please state your name, business address, and occupation.

A. My name is T. S. (Ted) Spangenberg, Jr. My business address is One Energy Place, Pensacola, Florida 32520. I am employed by Gulf Power Company as its Residential Marketing Manager.

Q. Are you the same Ted Spangenberg that presented direct testimony in this Docket?

A. Yes, I am.

Q. Do you have an exhibit to which you will refer in your testimony?

A. Yes, I have an exhibit consisting of one schedule, (TSS-2). This exhibit consists of two pages and contains the following:

1. Table of approved utility conservation programs and analysis life.
2. Copy of page 35.2 from the 1999 edition of the ASHRAE HVAC Applications Handbook.

Q. Have you reviewed the direct testimony and Exhibit __ (JWM-1) submitted by Mr. Joseph W. McCormick on August 5, 1999 on behalf of Peoples Gas System in opposition to Gulf's petition in this Docket?
A. Yes, I have.

Q. Do you disagree with any of the positions or statements of Mr. McCormick in that testimony?
A. Yes. Mr. McCormick cites four assumptions used by Gulf with which he disagrees. His claim is that, if these four assumptions are "corrected", the program would fail the Commission's tests for program approval. Those assumptions of Gulf are as follows:

1. Basing the electrical impacts on replacing 7 SEER HVAC equipment with 11 SEER equipment.
2. Not utilizing a replacement heat pump life of 15 years.
3. Inclusion of the monthly customer charge in the assumption for the cost of gas.
4. The program contributing to a decrease in summer demand.

In addition to those assumptions, he cites aspects of electrical system impact relative to his understanding of the requirements of FEECA as reasons for rejection of this proposed program by the Commission. It is my position that for only one of the four assumptions objected to by Mr. McCormick does he also present valid reasons for objection which should be given any consideration by the Commission; that is the one dealing with the gas cost utilized by Gulf in its analysis. The remainder of his objections are without merit.

Q. What is your response to his discussions regarding the appropriate equipment efficiency changes for use in Gulf's analysis?

A. As noted earlier, Mr. McCormick disagrees with Gulf's basing the expected electrical impacts of its proposed program on replacing 7 SEER HVAC equipment with 11 SEER equipment. He indicates a belief that HVAC equipment in the age range of 10 to 15 years is "at very nearly the end of their useful service lives."

His claim of a 10 to 15 year age correlating to equipment being at the end of its normal life appears to be based totally on an ASHRAE table of service life which he has included in his exhibit. He does not appear to have understood the studies and the data behind the table, nor does his testimony appear to properly consider the concept of "median" service life, the definition of "service life", or the past and continuing improvement in expected service life. A thorough discussion of the errors in Mr. McCormick's testimony about HVAC service life is contained in the rebuttal testimony of Gulf's witness, Mr. David Shell, which has also been filed in this Docket.

Mr. Shell's testimony makes it clear that the low efficiency units which would be candidates for replacement by Gulf's program are not "at very nearly the end of their normal useful lives" and would not be expected, with any reasonable degree of probability, to otherwise be replaced by the customer. Additionally, Gulf expects its program to specifically encourage customers to change out their equipment prior to the end of its functional life. The $200 customer rebate that will be offered as part of this program, in many cases, will be the very thing that encourages customers to go ahead and make the change to higher efficiency. This is specifically the case for those customers who wish to improve energy efficiency solely for the sake of energy efficiency itself, those who aspire to reduced energy costs, those who want the more uniform heating effect of a heat pump, or those who are concerned about the environment and would consider the change as an act of environmental stewardship. This program will clearly encourage these prospective but hesitant participants to go ahead and make the change and, for all of those instances, the appropriate SEER change for analysis is undeniably the SEER of the unit coming out versus the SEER of the unit going in as the replacement unit.

Gulf took a conservative approach in regard to the SEER assumptions that it used. Participation in Gulf's proposed program requires the installation of a heat pump system with a <u>minimum</u> efficiency of 11.0 SEER in the cooling cycle. In fact, although the program requires 11.0 SEER as a minimum, the average SEER installed under the program is expected to be well in excess of this level. For instance, in response to our past and current efforts to encourage customers to install high efficiency heat pump equipment, we are aware of 843 heat pumps installed by Gulf's customers in 1998 as a replacement for an existing heat pump or air conditioner, with the new equipment having an efficiency of at least 11.0 SEER. The average efficiency of those 843 systems was actually 12.8 SEER. In other words, Gulf could have legitimately used the greater annual kilowatt-hour and demand savings of substituting 12.8 SEER equipment for the old 7.0 SEER equipment, but chose to stay with the 11.0 SEER assumption in order to continue to present a conservative estimate of the savings to be achieved. These reasons and the true service life characteristics are all reasons why Gulf filed its program with the Commission using the SEER assumptions that it did.

Q. Are there other applications in which you disagree with Mr. McCormick's use of a 15 year normal useful life for heat pumps?

A. Yes, there are. Mr. McCormick utilizes the 15 year heat pump normal useful life assumption as the sole reason for his contention that the period of Gulf's program analysis should be limited to 15 years. As indicated in Mr. Shell's testimony, a 15 year service life assumption is even more flawed when applied to heat pumps currently being installed than it is in its application to previously installed HVAC equipment. These errors are further exacerbated by Mr. McCormick's confusion of "service life" with "useful life". As Mr. Shell points out, analyses using expected service life as a parameter should use something more in the order of at least 22 years rather than 15 years. Should the Commission take the position that program analysis life should be limited to initial equipment <u>service</u> life, the utilization of a 22-year analysis period would yield cost effectiveness test results that demonstrate that Gulf's program is cost effective from both a ratepayer perspective and a participant perspective.

Q. Were there any errors in the cost effectiveness data Gulf originally provided and Mr. McCormick's testimony relied upon for recommending rejection of this program?

A. Yes. One set of cost effectiveness numbers on Gulf's Exhibit TSS-1, page 9 of 9, was originally provided by Gulf and have since been found by Gulf to be in error. When the cost effectiveness calculation for the assumption of a SEER change from 10 to 11 and a 15 year analysis period was initially performed, the customer's expected equipment cost was incorrectly assumed to still be $3,000 as it was in the 7 SEER to 11 SEER scenario. In fact, under this particular scenario the applicable assumption is that the customer would already be upgrading their equipment to a minimum of 10 SEER. The incremental equipment cost to go beyond the 10 SEER air conditioner and gas furnace to an 11 SEER heat pump is expected to be $1,300. When this correction is made, as noted on the corrected Page 9 of Exhibit TSS-1, the program passes all three of the cost effectiveness tests as follows: RIM = 1.19, Participants = 1.39, TRC = 1.88. Even if Mr. McCormick's assumption recommendations are followed, the program still easily passes the Commission's cost effectiveness tests.

Q. Do you agree with the assertion in Mr. McCormick's testimony that RIM results are decreased if load is added?

A. No. Beginning at line 23 on page 8 Mr. McCormick's testimony cites the RIM test result of 1.19 for his preferred set of assumptions and then indicates that this "positive RIM test result could be diminished or reversed if this program leads to the addition of electric load through replacement of additional gas appliances." I assume that his testimony refers to annual kilowatt-hour consumption, since none of those other loads have any impact on weather sensitive peak demand. It would appear from his testimony that there is a misunderstanding of the economies of today's electric utility industry. During the time when the Commission's cost effectiveness rules were being developed it was likely the case that an addition of kilowatt-hours resulted in a decreased RIM result. That was during a time when the cost of incremental generation tended to exceed the cost of embedded generation. In fact when the set of assumptions noted above is analyzed with the addition of, for example, 500 kWh per participant with all else remaining equal the RIM result <u>increases</u> from 1.19 to 1.32.

Q. Is Mr. McCormick correct in his presumption that program analysis life should be set equal to HVAC service life?

A. No. That presumption is not consistent with the past practice of this Commission in regard to the approval of other conservation programs of electric utilities in Florida. Page 1 of Exhibit TSS-2 contains a table showing the Docket Number, utility, program name, and program analysis life of several programs that have been approved by the Commission. Several of these are programs focused on HVAC equipment, yet none of them uses an analysis period as short as what Mr. McCormick suggests. It is my understanding that all of these programs utilized a program life related to an avoided or deferred utility resource, not the participant's expected equipment life.

An HVAC program analysis related to a program that defers or avoids utility facilities might be very conservatively limited to the expected useful life of the HVAC equipment in only one scenario. That is if there is a clear showing that the initial equipment is not likely to be replaced with similar advanced technology once it ultimately fails but, instead, is most likely to be replaced by equipment that reverts back to the former technology that the subject equipment originally replaced. As discussed by Mr. Shell's testimony, that scenario is just not a reasonable expectation given the preponderant characteristic of customers to stick with a particular type of advanced (or even further advanced) technology once the switch has been made.

In making his recommendation for using HVAC service life Mr. McCormick not only ignored the past practice of the Commission, he also ignored the ASHRAE Handbook's reference to the very table that he relied upon for his 15 year contention. A copy of page 35.2 of the Handbook is included as page 2 of Exhibit TSS-2. It specifically addresses analysis periods for analyses of HVAC equipment and further indicates that "… the analysis period is often unrelated to the [HVAC] equipment depreciation period or service life…". It goes on to state that these [depreciation life or service life] may be important in the analysis, but, as Mr. Shell points out in his testimony, once a participant has installed a high-efficiency heat pump, there is a very high probability that he will replace it with similar, higher-efficiency equipment once the original equipment does reach the end of its service life.

Gulf's petition and the program analysis supporting its request for program approval properly utilizes the economic life of avoided utility facilities. Mr. McCormick's contention that it should be based on HVAC service life is not correct, much less his contention that it should be a service life of only 15 years.

Q. Do you have any observations with regard to that portion of Mr. McCormick's testimony that discusses the cost of gas that Gulf used in its program analysis?

A. Yes. Mr. McCormick states that "We believe Gulf's analysis inappropriately includes the customer charge in its calculation of the average gas price of $0.95 therm." He goes on to indicate that this overstates the cost of gas, particularly for those customers who have other gas appliances in addition to a gas furnace. Because there are many gas furnace customers who also have other gas appliances, the inclusion of the customer charge results in some liberalism in the gas cost assumption.

Gulf's gas cost assumption was intended to focus on all combustion furnace applications throughout

Northwest Florida, or, more specifically, any Gulf Power customer who was currently utilizing an older, inefficient combustion fuel appliance as their primary heating source. This presents the greatest opportunity for energy conservation and demand reduction through substitution with a heat pump. There are eight natural gas distributors offering residential service in Northwest Florida through the use of 13 different residential rate schedules. The additional rate schedules are due to the practice of some distributors, specifically those owned by a municipality, of offering different pricing to customers inside versus outside of their municipal boundaries. Only four of the eight distributors and six of the 13 rate schedules include a customer charge on their monthly billing to residential customers. These charges range from $4 to $7 per month. So, to be more precise, Gulf's failure to remove the customer charge from the gas cost only introduced liberalism to the extent of multiple gas appliance customers on those 6 of the 13 rate schedules.

However, to the extent that there are customers who have only a gas furnace, it is conservative, and in all other respects Gulf's gas cost assumption was conservative.

Q. In what ways was Gulf's gas cost assumption conservative?

A. First, Gulf's gas cost figures do not factor in the cost of propane for Gulf's customers who have a propane fueled heating appliance. A second area of conservatism is in the total therms of gas savings assumed by Gulf in its analysis.

Q. How did the exclusion of propane costs understate the weighted average gas cost?

A. As noted on page 18 of Mr. McCormick's exhibit, propane costs for the three more populated areas of Northwest Florida range from $1.089 to $1.375 per therm. Additionally, propane costs in the smaller towns and rural areas along the I-10 corridor are in this same general range. Inclusion of these costs in the calculation of a Northwest Florida weighted average cost of combustion fuels would, without question, yield a higher figure than what Gulf utilized, all other things being equal.

Q. How did the assumption about the therms of gas to be conserved understate the gas cost savings the typical customer would experience?

A. In the determination of energy savings, Gulf utilized, as indicated on page 9 of Exhibit TSS-1, an Average Fuel Utilization Efficiency (AFUE) of 68% for the gas heating equipment to be displaced. This AFUE rating is the type of rating used to characterize furnace efficiencies as reported by the Gas Appliance Manufacturers Association (GAMA) and rates the furnace for use in an annual climate with 2,080 heating load hours, in other words, the heating load expected in states like New Jersey, Ohio, and Illinois. Heat pumps will have a higher average heating efficiency than their national rating when used in Northwest Florida, due to the higher average outdoor ambient temperature for heat exchange. Gas furnaces, on the contrary, will have a lower efficiency than that reported by GAMA when used in our region. We experience less than half of the rated heating load hours. Our higher average outdoor ambient winter temperatures cause much more cycling on and off and much less average run time for furnaces compared to applications in sustained, colder climates, thus, yielding a significantly lower actual realized furnace efficiency than the rating assigned by GAMA. Once again, in order to be conservative in our analysis of cost effectiveness Gulf chose to ignore the resulting understatement of the therms of gas that would be conserved.

Q. Is it your belief that the elements of conservatism just noted balance out the liberalism of the inclusion of the customer charge in those situations where applicable?

A. Yes. However, I have analyzed the effect of removal of the customer charges for these six rate schedules on the average natural gas price in Northwest Florida. Removal of the customer charge results in a reduction in the weighted average cost of natural gas for the eight Northwest Florida distributors from 95.0 cents per therm to 86.4 cents per therm. Although for Peoples Gas the average price per therm would be reduced to 74.2 cents per therm as stated in the testimony of Mr. McCormick, it is important to remember that this would only be applicable to Peoples Gas customers and only to those who have other gas appliances in addition to a gas heating device.

Q. How would this change in the assumed average gas price affect the cost effectiveness calculations of this program?

A. The lower weighted average price would result in slightly lower energy bill savings to a customer converting from a 7.0 SEER A/C and gas furnace to an 11.0 SEER heat pump, thereby reducing the benefit/cost ratio of the Participant's test and the TRC test. The three cost effectiveness tests all remain well above 1.0 with the precise results as follows:

RIM Test = 1.74
Participant's Test = 1.52
TRC Test = 1.99

Q. Did you also perform the analysis using Peoples Gas rates?

A. Yes. We analyzed the effect of these calculations with gas cost savings calculated at Peoples Gas price of $0.724 per therm. Again, the resulting numbers were all above 1.0 and are as follows:

RIM Test = 1.74
Participant's Test = 1.35
TRC Test = 1.72

In other words, even though there are several respects in which a gas price of 86.4 cents, and, even more so, a gas price of 74.2 cents understates the average expected gas fuel cost, when either of these figures is utilized Gulf's proposed program is still cost effective.

Q. Is Mr. McCormick's testimony correct in the assertion that the demand reduction benefits will be diminished or reversed if this program leads to the replacement of additional gas appliances?

A. No. To start with, this program is certainly not targeted at any other gas uses in the home. Additionally, Mr. McCormick bases his argument on the change in average gas cost when the gas furnace is no longer there to help absorb the economic impact of the gas customer charge. He would have us remove the customer charge for the purposes of Gulf's program analysis, but wishes it included in a customer's consideration of whether to keep any other gas appliances in the home. His customer charge argument in this particular application is valid only to the extent customers decide to totally and immediately remove all gas uses in their home. In the case of gas cooking and gas drying, rarely was the customer's decision to utilize gas for those applications made solely on the basis of the cost of fuel. The amount of a typical customer's monthly household budget that is spent on these applications is relatively small compared to the cost that would be incurred to make the wiring changes necessary to replace this equipment with electric equipment. More often than not, decisions to make such a replacement are driven by safety or other concerns rather than monthly energy cost concerns.

Q. Does this HVAC program include water heating as a part of the program?

A. No. Mr. McCormick's testimony references a water heating program that Gulf has in place and suggests that a customer converting a water heater from gas to electric under that program would offset the demand reductions the proposed GoodCents Conversion program for HVAC equipment. In the first place, the water heater program is not a subject of this docket. In this case we are dealing with an <u>HVAC</u> energy efficiency and conservation program that is proposed for ECCR treatment. These two programs do not have any programmatic linkages between them.

Although Mr. McCormick's testimony made note that Gulf's water heating program requires the installation of a timer, it failed to mention the purpose of the timer - that is to help ensure that the installation of a water heater under that program does not make any contribution to the growth rate of Gulf's summer peak demand. In reviewing installations of those water heaters Gulf's Residential Energy Consultants make personal inspections of timer settings to ensure they are set so as to avoid being "on" during the normal expected hours of Gulf's summer peak demand. Further, in claiming that the HVAC program's demand reduction will be offset by the addition of more water heaters, Mr. McCormick has presumed the Commission would accept his flawed premise of a 0.3 kW reduction in HVAC demand rather than the 1.9 kW reduction it will actually achieve. He inappropriately characterizes a 0.3 kW demand reduction as "slim", and then would have the Commission believe that the coincident demand of a water heater is greater than this 0.3 kW. This is not the case.

Third, just as is often the case for cooking and drying, should a customer decide to replace their gas water heater with an electric one, it is often on the basis of safety concerns or the desire for a faster recovery to a usable hot water temperature, rather than on the basis of the monthly energy cost of operating one versus the other.

Q. What elements of Mr. McCormick's discussion of electrical system impact relative to FEECA do you believe to be in error?

A. On line 11 of page 11 of his testimony Mr. McCormick commences a sentence in which he, first, would have the Commission believe that an increase in annual kilowatt-hour consumption due to this program is undeniable. That simply is not the case. His statement is based precariously upon the premise that the Commission would find that Gulf's assumption of a change from 7.0 SEER to 11.0 SEER is incorrect. On the contrary, Mr. Shell's discussion of expected service life and my own testimony in that regard indicate that, not only is the assumption of 7 SEER to 11 SEER correct, it has an element of conservatism in it. I believe if the Commission is concerned about the advisability of allowing the assumption of 7 SEER to 11 SEER, it should look to its own prior decisions and the "liberally construed" language within FEECA for encouragement in its attempts to make as many cost-effective energy efficiency and conservation programs available to the citizens of Florida as practical. The assumption of 7 SEER to 11 SEER should be allowed and the result is a 1390 kWh per participant per year <u>decrease</u> in electrical energy consumption, in addition to the decrease of 302 therms or more of gas consumption.

Second, Mr. McCormick's testimony suggests that the Commission should not approve any program that, while reducing peak system demand, either increases off-peak weather sensitive demand and/or annual kWh consumption. That approach is contrary to the Commission's past actions in this regard. Typically, any direct load control program involving HVAC systems, including those approved by the Commission and listed on page 1 of Exhibit TSS-2, involve increases in annual energy consumption. These increases tend to be small relative to the demand reduction, are always off-peak, and are believed to be due to the customer's "reactive" behavioral response associated with the loss of comfort during the period of load control. Mr. McCormick's interpretation of FEECA would seem to preclude the allowance of such programs simply on the basis of a logical and reasonable expectation of some increase in annual electrical energy consumption.

Additionally, the Commission has encouraged the consideration of off-peak thermal storage programs. Due to the less than 100% efficiency of energy storage and energy transfer technologies that must be utilized by such systems, any reduction in demand will always result in an increase in off-peak energy and a net increase in annual energy. Mr. McCormick's interpretation of FEECA would also seem to preclude the allowance of these demand-side management programs.

It is ironic that Mr. McCormick would have the Commission reject Gulf's program on the basis of an expected increase in Gulf's off-peak weather sensitive demand and/or on the basis of, though falsely presumed, an expected increase in annual kilowatt-hour consumption, while making no acknowledgement of the program's additional benefits of reducing the peak weather-sensitive demand for natural gas or the reduction in annual consumption of natural gas and ground-source Btu's. Such rigid and restrictive interpretation, even absent erroneous assertions about the impact of Gulf's program, is not consistent with the stated intent of FEECA. The only <u>restrictive</u> language within FEECA is that pertaining to the requirement that a program be cost effective. The rest of the language in FEECA is structured to be <u>permissive</u>. If a program meets any aspect of FEECA, thereby improving the efficiency of energy utilization in Florida, it should be approved by this Commission as long as it is cost effective.

As noted earlier in my testimony, additional load, though not the focus, purpose, or expected result of Gulf's proposed program, in fact, yields positive results for Gulf's general body of ratepayers as long as it is not accompanied by an inordinate amount, if any, of increased peak demand. The cost of many forms of new electrical generation today is often less than the cost of embedded generation. FEECA is still applicable under these conditions because it encourages efficiency programs that put the focus where it should be, on the reduction of system peak demand. This is the case even in instances (e.g. direct load control, thermal energy storage, other off-peak load shifting, etc.) where there might otherwise be a temptation towards accusations of load building or towards complaining because of the natural competitive impact of any efficiency program.

It is also our belief that FEECA should be fairly applied with respect to electric utilities versus gas utilities. We believe Gulf's proposed program to be at least as consistent with FEECA as the approved ECCR programs of gas utilities such as Peoples Gas.

Q. Does that conclude your testimony?
A. Yes, it does.

AFFIDAVIT

STATE OF FLORIDA)
)
COUNTY OF ESCAMBIA)

Docket No. 981591-EG

Before me the undersigned authority, personally appeared T. S. Spangenberg, Jr., who being first duly sworn, deposes and says that he is the Residential Marketing Manager of Gulf Power Company, a Maine Corporation, that the foregoing is true and correct to the best of his knowledge, information and belief. He is personally known to me.

T. S. Spangenberg, Jr.
Residential Marketing Manager

Sworn to and subscribed before me this 25th day of August, 1999.

Notary Public, State of Florida at Large

Jessica L. Pfeiffer
MY COMMISSION EXPIRES
FEBRUARY 7, 2001
#CC 619321
Bonded thru
Troy Fain-Insurance
NOTARY PUBLIC, STATE OF FLORIDA

Table of Selected FPSC-Approved Energy Efficiency and Conservation Programs

Docket No.	Utility	Program Name	Analysis Period
941171-EI	Florida Power Corp.	Home Energy Improvement	30 years
941171-EI	Florida Power Corp.	Better Business	30 years
941171-EI	Florida Power Corp.	Commercial Energy Management	30 years
941170-EG	Florida Power & Light	Residential Air Conditioning	23 years
941170-EG	Florida Power & Light	Residential Load Management ("On Call")	23 years
941170-EG	Florida Power & Light	Business Custom Incentive/Refrigeration	27 years
941173-EG	Tampa Electric Company	Residential Heating & Cooling	19 years
941173-EG	Tampa Electric Company	Prime Time Load Management	30 years
941173-EG	Tampa Electric Company	Commercial/Industrial Load Management	30 years

Table 2 Initial Cost Checklist

Energy and Fuel Service Costs
Fuel service, storage, handling, piping, and distribution costs
Electrical service entrance and distribution equipment costs
Total energy plant
Heat-Producing Equipment
Boilers and furnaces
Steam-water converters
Heat pumps or resistance heaters
Makeup air heaters
Heat-producing equipment auxiliaries
Refrigeration Equipment
Compressors, chillers, or absorption units
Cooling towers, condensers, well water supplies
Refrigeration equipment auxiliaries
Heat Distribution Equipment
Pumps, reducing valves, piping, piping insulation, etc.
Terminal units or devices
Cooling Distribution Equipment
Pumps, piping, piping insulation, condensate drains, etc.
Terminal units, mixing boxes, diffusers, grilles, etc.
Air Treatment and Distribution Equipment
Air heaters, humidifiers, dehumidifiers, filters, etc.
Fans, ducts, duct insulation, dampers, etc.
Exhaust and return systems
System and Controls Automation
Terminal or zone controls
System program control
Alarms and indicator system
Building Construction and Alteration
Mechanical and electric space
Chimneys and flues
Building insulation
Solar radiation controls
Acoustical and vibration treatment
Distribution shafts, machinery foundations, furring

Analysis Period

The time frame over which an economic analysis is performed greatly affects the results of the analysis. The analysis period is usually determined by specific analysis objectives, such as length of planned ownership or loan repayment period. The chosen analysis period is often unrelated to the equipment depreciation period or service life, although these factors may be important in the analysis.

Table 3 lists representative estimates of the service life of various system components. Service life as used here is the time during which a particular system or component remains in its original service application. Replacement may be for any reason, including, but not limited to, failure, general obsolescence, reduced reliability, excessive maintenance cost, and changed system requirements due to such influences as building characteristics, energy prices, or environmental considerations.

Depreciation periods are usually set by federal, state, or local tax laws, which change periodically. Applicable tax laws should be consulted for more information on depreciation.

Interest or Discount Rate

Most major economic analyses consider the opportunity cost of borrowing money, inflation, and the time value of money. **Opportunity cost** of money reflects the earnings that investing (or loaning) the money can produce. **Inflation** (price escalation) decreases the purchasing or investing power (value) of future money because it can buy less in the future. **Time value** of money reflects the fact that money received today is more useful than the same amount received a year from now, even with zero inflation, because the money is available earlier for reinvestment.

The cost or value of money must also be considered. When borrowing money, a percentage fee or interest rate must normally be paid. However, the interest rate may not necessarily be the correct cost of money to use in an economic analysis. Another factor, called the **discount rate**, is more commonly used to reflect the true cost of money. Discount rates used for analyses vary depending on individual investment, profit, and other opportunities. Interest rates, in contrast, tend to be more centrally fixed by lending institutions.

To minimize the confusion caused by the vague definition and variable nature of discount rates, the U.S. government has specified particular discount rates that can be used in economic analyses relating to federal expenditures. These discount rates are updated annually (Lippiatt 1994, OMB 1972, NIST) but may not be appropriate for private sector economic analyses.

Periodic Costs

Regularly or periodically recurring costs include insurance, property taxes, income taxes, rent, refurbishment expenses, disposal fees (e.g., refrigerant recycling costs), occasional major repair costs, and decommissioning expenses.

Insurance. Insurance reimburses a property owner for a financial loss so that equipment can be repaired or replaced. Insurance often indemnifies the owner from liability as well. Financial recovery may include replacing income, rents, or profits lost due to property damage.

Some of the principal factors that influence the total annual insurance premium are building size, construction materials, amount and size of mechanical equipment, geographic location, and policy deductibles. Some regulations set minimum required insurance coverages and premiums that may be charged for various forms of insurable property.

Property Taxes. Property taxes differ widely and may be collected by one or more agencies, such as state, county, or local governments or special assessment districts. Furthermore, property taxes may apply to both real (land, buildings) and personal (everything else) property. Property taxes are most often calculated as a percentage of assessed value but are also determined in other ways, such as fixed fees, license fees, registration fees, etc. Moreover, definitions of assessed value vary widely in different geographic areas. Tax experts should be consulted for applicable practices in a given area.

Income Taxes. Taxes are generally imposed in proportion to net income, after allowance for expenses, depreciation, and numerous other factors. Special tax treatment is often granted to encourage certain investments. Income tax experts can provide up-to-date information on income tax treatments.

Additional Periodic Costs. Examples of additional costs include changes in regulations that require unscheduled equipment refurbishment to eliminate use of hazardous substances, and disposal costs for such substances. Moreover, at the end of the equipment's useful life there may be negative salvage value (i.e., removal, disposal, or decommissioning costs).

OPERATING COSTS

Operating costs are those incurred by the actual operation of the system. They include costs of fuel and electricity, wages, supplies, water, material, and maintenance parts and services. Chapter 30 of the 1997 *ASHRAE Handbook—Fundamentals* outlines how fuel and electrical requirements are estimated. Note that total energy consumption cannot generally be multiplied by a per unit energy cost to arrive at annual utility cost.