SECTION 1 – GENERAL

The Energy Conservation and Management Policy was adopted by the Wake County Board of Commissioners in 1992 in order to encourage energy efficiency and improve environmental quality in Wake County's public facilities. The policy forms the basis for the development of **Guidelines for Design and Construction of Energy Efficient County Government Facilities and Schools**.

1.1 ENERGY CONSERVATION AND MANAGEMENT POLICY

All Wake County employees share in the responsibility for the implementation of this energy policy and must be diligent in their efforts to conserve resources and use energy efficiently. Because of the complex environmental, economic and social consequences of the use of finite energy resources, appropriate procedures must be employed in the design, construction, operation and maintenance of buildings as well as in the purchase, operation and maintenance of equipment and vehicles.

- Wake County shall employ appropriate staff and consultants whose assigned responsibilities include the development and implementation of energy conservation programs.

- The respective Energy Conservation Advisor for Wake County and Wake County Public Schools shall determine annually an energy consumption goal to be used in the preparation of facility operating budgets. Budget requests for the operation and maintenance of existing facilities' equipment shall include adequate funds to maintain and enhance the operating efficiency of building systems and equipment.

- Proposed capital budgets shall provide for quality, energy-efficient facilities and equipment which meet or exceed the performance criteria established in the *Guidelines*

- The *Guidelines,* developed jointly by Wake County and Wake County Public School System, shall be periodically reviewed by the Wake County Citizens Energy Advisory Commission. The *Guidelines* shall include design standards, energy goals, economic assumptions for life cycle cost analysis and other building system and technology criteria. Architects and engineers shall be required to demonstrate that their designs conform to these *Guidelines* to the satisfaction of the professional staff of the governmental entity with primary responsibility for each project.

- The process of selecting teams of architects, engineers and other design consultants shall assure that design teams are fully qualified to provide the necessary professional services including the demonstrated ability to conduct the energy analysis services as indicated in the *Guidelines*.

- Professional services agreements with design professionals shall require designers to follow the *Guidelines*. The total design fee shall be adequate to support the requested comprehensive design services.

- Energy analysis shall be performed by design teams at appropriate intervals after completion of new buildings at the request of the Owner if the actual energy consumption exceeds expected energy consumption based on the initial energy analysis. This shall be considered as an additional service to be negotiated with the facility management staff and not part of the basic design services.

- Facilities Management staff shall develop and implement guidelines that specify procedures for the operation and maintenance of facilities during occupied and unoccupied times, and shall review guidelines annually.

- Energy use and cost data for each major facility shall be monitored monthly and reported upon request to the Wake County Citizen's Energy Advisory Commission. Data shall be reviewed annually by the staff and, at which time, goals are established for each major facility.

- The respective Energy Conservation Advisor for Wake County and WCPSS shall review consumption data and energy related maintenance and operational activity as presented in reports, facility audits and studies conducted during the previous year and shall prepare a report, in coordination with the Energy Commission, which recommends capital needs for energy retrofit to be considered in future building programs.

- The Facilities Management staff of Wake County and the Wake County Public School System shall develop specific emergency energy conservation guidelines that may be implemented in the event of an energy emergency. These guidelines shall include shut-down priorities and procedures that may be implemented during periods of energy or funding crisis and be reviewed annually.

1.2 CONSTRUCTION BUDGET

The establishment of a reasonable construction budget is one of the most critical items in attaining a good quality, energy-efficient facility. An unrealistically low budget will cause problems throughout design, construction and after occupancy. A building may be inexpensive to build but may be very expensive to operate and maintain. Facility operating costs over the life of a building typically far exceed the initial capital construction cost. Therefore, long-term operating costs must be given special consideration separate from the initial "goal setting" for projects through each step of the programming, design and construction process.

Retrofitting and renovating facilities to improve energy performance is sometimes very costly and is generally difficult; therefore it is imperative that the Design Team be responsible for performing appropriate analyses of building systems during the design phase. This approach will increase the cost for professional fees, but it will result in higher quality facilities and lower facility operating costs. A careful balance between initial construction cost and projected long range facility operating costs is an essential part of a successful public project.

1.3 ENERGY EFFICIENCY

The Design Team must create an energy efficient facility that meets or exceeds energy efficient goals stated herein and still remains within the construction budget. The design must incorporate the best possible "life-cycle" energy solutions that provide reasonable payback periods and are serviceable by the maintenance staff. The facility should also be environmentally-sensitive and be a healthy building for employees, customers, students and visitors.

1.4 ENERGY BUDGET AND ENERGY GOAL

The most important energy programming criteria is performance. The following Energy Budgets and Energy Goals were established as benchmarks upon which to judge a project's success. The Energy Budget numbers, listed by the particular building type, reflect the minimum energy performance that is required. Achievement of the Energy Goal is considered to be excellent. These numbers were derived by analyzing standards applicable to our immediate climatic area as well as project data for local projects of similar type.

BUILDING TYPE	* ENERGY BUDGET (BTU'S/SQ.FT/YEAR)	*ENERGY GOAL (BTU'S/SQ.FT/YEAR)
Human Services Facilities (Clinics)	53,900	44,100
Libraries (Community Center)***	45,100	36,900
Maintenance Buildings and Warehouses	25,300	20,700
Office Buildings:		
- One and Two Story	44,000	36,000
- High Rise	48,400	39,600
Schools:		
- K-5	39,600	32,400
- Middle and High Schools	50,600	41,400
- Gymnasiums	55,000	45,000
24/7 Facilities	(see note**)	(see note**)
Other Building Types:	(see note**)	(see note**)

* Energy Budget numbers reflect a value which is ten percent higher than the Building Energy Performance Standards developed by the US Department of Energy. The Energy Goals reflect values which are ten percent lower than the US Department of Energy's Building Energy Performance Standards. It includes a ventilation rate recommended by recent ASHRAE Standard 62.1.

** If the building to be designed is not representative of any of the above categories, a specific "Energy Budget" and "Energy Goal" shall be developed by Wake County, with input from the Design Team. This Budget and Goal shall be established during the Programming Phase.

*** Energy Budget and Goal based upon 10 hours per day 12 months per year for typical annual operation.

1.5 ENERGY STATUS REPORT

The Designer must prepare and submit an Energy Status Report at each phase of the design. The reporting form, which is included at the end of the section, is intended to aid the designer in monitoring energy efficiency goals set by Wake County and Wake County Public School System.

1.6 PRIORITIES FOR ENERGY CONSERVATION STRATEGIES

In addition to evaluating quantifiable, analytical results and Btu consumption numbers, there are other factors which should be considered when evaluating overall energy design. In general, it is desirable to use natural energy solutions (i.e., daylighting, passive heating and cooling) before mechanical ones. Solutions should be used which have minimal environmental impact and result in better indoor air quality. Daylighting should be considered a high priority for projects because, in addition to energy savings, productivity and health are also improved. Low maintenance solutions requirements are, obviously, the best option.

1.7 LIFE-CYCLE ANALYSIS

The purpose of a life-cycle analysis is to compare alternative design options available for the project and select the most cost-effective design option. Alternative design elements that (1) have different first costs and/or (2) will impact operating and/or maintenance costs differently must be compared using a common component.

A. The life-cycle cost analysis shall include, but is not limited to, the following components:

- The coordination, orientation, and positioning of the facility on its physical site;
- The amount and type of fenestration employed in the facility;
- Thermal characteristics of materials and the amount of insulation incorporated into the facility design; and
- The variable occupancy and operating conditions of the facility, including illumination levels.

B. The initial estimated cost of each energy-consuming system being compared and evaluated shall include, but is not limited to, the following elements;

- The estimated annual operating cost of all utility requirements;
- The estimated annual cost of maintaining each energy-consuming system; and
- The average estimated replacement cost for each system expressed in annual terms for the life expectancy of the facility.

C. The life-cycle cost analysis shall be certified by a registered professional engineer or bear the seal of a North Carolina registered architect, or both as required by the respective licensing board.

D. The Designer shall use the life-cycle cost analysis over the life expectancy of the facility in selecting the optimum system or combination of systems to be incorporated in the design of the facility. The energy consumption analysis of the operation of energy-consuming systems in a facility shall include, but is not limited to:

- The comparison of three or more system alternatives;
- The simulation or engineering evaluation of each system over the entire range of operation of the facility for a year's operating period; and
- The engineering evaluation of the energy consumption of component equipment in each system considering the operation of such components expected at expected load based on hourly weather data other than full or rated outputs.

1.8 CRITERIA FOR LIFECYCLE COST ANALYSIS

A life-cycle cost analysis shall be used to evaluate the cost effectiveness of various design options to be implemented in building design. Various analytical methods have been used by designers to evaluate the appropriateness of incorporating optional energy saving measures. However, only the life-cycle cost (LCC) analysis totally evaluates what is in the best, long-term interest of the Owner. By incorporating life-cycle cost approaches throughout, all reasonable energy options can be compared on an equal level.

A comprehensive LifeCycle Cost Analysis (LCCA) method for North Carolina State Facilities was issued by the North Carolina State Construction Office on October 1, 2001. This method can be downloaded at:

HTTP://INTERSCOPE2.DOA.STATE.NC.US/GUIDELINES/LCCA_LINK.HTM

1.8.1 FACTORS TO CONSIDER IN ANALYSIS

The following factors should be included in a life-cycle cost analysis of various design options:

- Initial cost
- Energy operating costs
- Maintenance cost (over the expected life of a building)
- Useful life
- Energy inflation costs
- Replacement inflation costs

1.8.2 BUILDING COMPONENTS TO CONSIDER IN ANALYSIS

On the following page, Table 1-1 identifies most of the components that should be considered and analyzed by the designers in preparing life-cycle cost analysis for a project.

Table 1-1

Building Component	Typical Alternatives
Architecture	Substructure
	❑ Foundations
	❑ Slab on grade
	❑ Basement excavation
	❑ Basement and retaining walls
	Superstructure
	❑ Floor construction
	❑ Roof construction
	❑ Stair construction
	Wall Construction
	❑ Increased insulation levels, insulation placement, etc.
	❑ Mass (passive solar thermal storage)
	❑ Daylighting
	❑ Building envelope (exterior closure) type
	Fenestration
	❑ Type, amount, and location/orientation of glass
	❑ Indoor/outdoor shading devices
	❑ Daylighting
	Interior space plan
	❑ Space arrangement
	❑ Circulation
	❑ Finishes and colors
	❑ Ceiling heights
	Roof construction
	❑ Increased insulation levels, type of insulation
	❑ Roof membrane type and color
	❑ Daylighting
	Conveyances
	❑ Selection of elevators and dumbwaiters
	❑ Escalators
HVAC	Secondary HVAC system(s)
	❑ System(s) type(s) and zoning
	❑ Economizer cycle(s)
	❑ Heat recovery (exhaust air, internal source, etc.)
	Primary HVAC system(s)
	❑ System(s) type(s) and energy sources
	❑ Pumping/piping configuration
	❑ Heat recovery, waterside economizer cycle, etc.
	❑ Thermal storage (electrical demand shifting)
Plumbing	Plumbing system(s)
	❑ Domestic hot water generation (method and energy source)
Electrical	Lighting
	❑ Artificial lighting levels, methods, and control, including general lighting and task lighting.
	❑ Daylighting
	Power
	❑ Voltage selection (building and large equipment)
	❑ Transformers (quantity, locations, efficiencies)

1.8.3 ESTIMATING INITIAL COST FOR THE ANALYSIS

The capital costs associated with an alternative include all costs that would be incurred in the design and construction of that alternative. Using the Construction Standard Institute (CSI) format, relatively accurate cost estimates can be prepared by evaluating the cost associated with various assemblies that make-up the total building.

1.8.4 ENERGY CONSUMPTION

The following is a list of computer-based energy calculation software programs that engineers, architects and analysts use to model and analyze requirements for buildings.

DOE-2 is a whole-building energy analysis program that calculates energy performance and life-cycle cost analysis. It can be used to analyze the energy efficiency of given designs or the efficiency of new technologies. Other uses include utility demand-side management and rebate programs, development and implementation of energy efficiency standards and compliance certification.

eQUEST *(Energy Quick Simulation Tool)* is based on *DOE-2*, but includes graphics and help wizards that provide sophisticated building energy use simulation without requiring extensive experience in the art of building performance modeling.

HAP *(Hourly Analysis Program)* is a system design and energy simulation tool in one package. Version 4.0 of the program is Windows-based and uses a graphical user interface for input. The energy simulation module uses 1-hour time increments for a full year. This program, like *TRACE 700*, is designed for the practicing design engineer, but uses techniques very similar to *DOE-2.1* to calculate systems performance.

***TRACE* 700** (Trane Air Conditioning Economics) models virtually any building, any air system, any heating, cooling, or generating equipment, and any economic/utility scenario, and then helps to quickly compare them. The program takes you step-by-step from basic building parameters, such as geographic location, to complicated system modeling such as ice storage systems.

TRNSYS, commercially available since 1975, is designed to simulate the transient performance of thermal energy systems. *TRNSYS* allows users to completely describe and monitor all interactions between system components. Because the components are written in Fortran, a user can easily generate a *TRNSYS* component to model any new technology that is created. Historically, *TRNSYS* has been used for simulating solar thermal systems, modern renewable energy systems including PV and wind power, more general HVAC systems, and buildings.

The designers are encouraged to investigate other programs for use in their analyses, but programs should be submitted for approval before final analyses are performed.

Finally, the construction estimate must include, as applicable, a number of costs that are sometimes overlooked by designers. They are listed as follows:

- Special equipment and/or rigging;
- Demolition;
- Additional architectural and/or structural requirements associated with mechanical alternatives;
- Additional mechanical or electrical requirements associated with architectural alternatives;
- Contractor Overhead (Insurance, bonds, taxes, and special conditions), typically 10-15%; and
- Contractor Profit, typically 4-5%.

1.8.5 ENERGY ESCALATION RATES

Each April, the National Institute of Standards and Technology (NIST) of the US Department of Commerce publishes an annual supplement to their Handbook 135. This supplement updates energy price indices. These energy price indices should be used in preparing life cycle cost analyses.

Additional financial information for use in preparing LCC analyses such as inflation rates or bond financing in North Carolina are available on the State Construction Office website.

1.8.6 TIMEFRAME FOR LIFE-CYCLE COST ANALYSIS

The "estimated life" of the measure determines the period over which the life-cycle cost analysis is to be run. If the project involves a new building, the estimated life would be longer than that of a renovated structure. Likewise, building shell component decisions should be viewed in a larger context than equipment which is often replaced by new technologies. To provide a guide for the design team, the following timeframes are to be used in the modified life-cycle analysis. This modified approach (which multiplies the projected life of the facility time a factor or percentage) reflects a balance between what is best for the life of the facility and the importance of keeping initial cost low.

Type Of Measure	Projected Life Of Facility	Timeframe For LCC Analysis (% And Years)
New Construction		
Building Shell (Thermal Envelope)	50 years	50%, 25 years
• Office Buildings, Schools, Libraries,		50%, 25 years
Gymnasiums		50%, 15 years
• Maintenance Facilities		50%, 15 years
Mechanical Equipment,	30 years	
Electrical, Lighting and Controls	30 years	
Renovation		
Building Shell (Thermal Envelope)		
• Office Buildings, Schools, Libraries, Gymnasiums	*	50% *
• Maintenance	*	50% *
Mechanical Equipment,	*	50% *
Electrical, Lighting and Controls	*	50% *

* On renovation projects, Wake County and the design team will determine the projected remaining useful life of the facility or equipment. This projected life figure should be multiplied by the percentages listed above in order to determine the actual number of years to use in the modified life-cycle cost analysis.