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April 29, 1986

U.S. Department of Transportation

Federal Aviation Administration

Standard

DESIGN STANDARDS FOR ENERGY MANAGEMENT IN NAS PHYSICAL FACILITIES

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1. SCOPE

1.1 Scope. This standard shall apply to all physical facilities and support equipment that are owned, operated or leased by the Federal Aviation Administration (FAA), or otherwise under the jurisdiction, occupancy or control of the FAA.

1.2 Purpose. This standard establishes requirements for energy management and conservation that shall be incorporated into the designs of new physical facilities and modifications to existing physical facilities in the NAS. Specific technical requirements for these facilities will be defined in subsystem or project specifications and in facility development specifications for each subsystem or project. This standard is primarily for use in the development of national standard designs and shall also be used for site adaptations by FAA Washington and Regional Offices in the development of engineering requirements and task orders. This standard is to be used by FAA Washington in preparation of the physical facilities requirements portions of the NAS subsystem or project specifications and by architects and engineers in the design and construction of new facilities and modifications to existing NAS physical facilities. This standard shall not be used to abridge any federal safety, health, or environmental code requirements.

2. APPLICABLE DOCUMENTS

2.1 Government documents. The following documents of the issue in effect on the date of invitation for bids or request for proposal, form a part of this standard to the extent specified herein. In the event of conflict between the documents referenced herein and the contents of this standard, the contents of this standard shall be considered a superseding requirement.

STANDARDS:

FAA

FAA-STD-032	Design Standards for National Airspace System Physical Facilities

OTHER PUBLICATIONS:

FAA Orders

6980.26	Battery Backup Power Systems - Theory and Selection Guidelines

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Manuals

Department of Energy (DOE)

DOE/AD-0006/1	DOE Facilities Solar Design Handbook
DOE/CS-0011	Introduction to Solar Heating and Cooling Design and Sizing
DOE/CS-0132	Architects and Engineers Guide to Energy Conservation in Existing Buildings
DOE/CS-0133	Identifying Retrofit Projects for Buildings
SOLAR/0811-79/01	Engineering Concerns in Solar System Design and Operation

General Services Administration (GSA)

Energy Conservation Guidelines for Existing Office Buildings
Energy Conservation Design Guidelines for New Office Buildings

Regulations and Codes

10 CFR 400 to 499	Energy
	Federal Register

Handbooks

National Bureau of Standards (NBS)

NBS Handbook 135	Life Cycle Cost Manual for the Federal Energy Management Program

Office of Management and Budget

Circular A-94	Discount Rates to be Used in Evaluating Time Distributed Costs and Benefits

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specified procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 Non-government documents. The following documents of the issue in effect on the date of invitation for bids or request for proposal form a part of this standard to the extent referenced herein. In the event of conflict between the documents referenced herein and the contents of this standard, the contents of this standard shall be considered a superseding requirement.

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OTHER PUBLICATIONS:

American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE)

	ASHRAE Handbook, Applications Volume
	ASHRAE Handbook, Equipment Volume
	ASHRAE Handbook, Systems Volume
90A,C	Energy Conservation in New Building Design

National Electrical Manufacturers' Association (NEMA)

MG-10	Energy Guide for Selection and Use of Polyphase Motors
MG-11	Energy Management Guide for Selection and Use of Single Phase Motors

Council of American Building Officials (CABO)

CABO Model Energy Code

Building Officials and Code Administrators International (BOCA), Inc.

BOCA Basic/National Energy Conservation Code

Brick Institute of America (BIA)
1750 Old Meadow Road, McLean, VA 22102

4, 4A - 4H	Technical Notes on Brick Construction

Commercial/Industrial Committee, Edison Electric Institute (EEI),
111 Nineteenth Street, N.W., Washington, D. C. 20036

EEI Energy Management Handbook

Technical society and technical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.

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3.0 REQUIREMENTS

3.1 General. This standard establishes design requirements (as defined in 6.2.2) prescribed by codes and industry standards and sets forth the framework for considering and evaluating other design requirements for energy management and conservation. The requirements of this standard are not necessarily imposed on the designs of all physical facilities (as defined in 6.2.2). The applicability of this standard is defined in the FAA engineering requirement, task order or NAS subsystem or project specification. All energy management and conservation measures (as defined in 6.2.2) shall be cost effective and designs implementing these measures shall be in accordance with FAA-STD-032.

3.1.1 Air traffic control (ATC) mission impact. The impact of an energy conservation measure on ATC missions shall be assessed. No energy management and conservation measure, regardless of its technical and economic merit, shall degrade ATC mission objectives, safety and reliability but rather shall enhance those objectives wherever possible.

3.1.2 Current proven technology. All designs shall be of current proven technology. Systems and equipment shall be reliable, maintainable, and readily available in the market place.

3.1.3 Design objectives. The energy related designs shall meet the following objectives:

a. Reduce the life cycle cost of energy consuming facilities, systems, and equipment;

b. Reduce the total cost of energy consumed;

c. Reduce the total energy consumption;

d. Promote the efficient use of energy through better control and increased use of more efficient equipment;

e. Promote switching from petroleum based fuels and natural gas to other energy sources such as sunlight and wind, etc.

3.1.4 Energy sources.

3.1.4.1 Non-renewable energy sources. In the selection and analyses of non-renewable energy sources (as defined in 6.2.2) for any energy consuming system, the most accurate applicable current and projected prices and market availability of the various energy sources at the project site shall be evaluated (as defined in 6.2.2). The availability of the non-renewable energy, including the impact of disruptions due to foreseeable fuel shortages, shall be considered for the duration of the useful life of the physical facility. Specific data may be obtained from the following sources:

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a. Federal Register;

b. 10 CFR 436, Subpart A;

c. NBS Handbook 135;

d. Energy distribution utility companies in the area of the project.

3.1.4.2 Alternative/renewable energy sources. Alternative/renewable energy sources (as defined in 6.2.2) shall be evaluated when they can be shown to be cost effective and when otherwise directed by FAA.

3.1.4.2.1 Alternative/renewable electric power sources. Alternative/renewable electric power sources shall be in accordance with FAA Order 6980.26. These sources include but are not limited to:

a. Sunlight;

b. Photovoltaic cells (as defined in 6.2.2);

c. Wind energy systems;

d. Fuel cells (as defined in 6.2.2);

e. Thermoelectric generators (as defined in 6.2.2);

f. Thermionic generators.

3.1.4.2.2 Solar thermal energy systems. Solar thermal energy (as defined 6.2.2) system design shall be in accordance with ASHRAE Handbook, Systems and Applications Volumes and DOE/AD-0006/1, DOE/CS-0011 and SOLAR/0811-79/01. Solar panels shall be vandal proof and shall be installed where they will not be subjected to shade from trees, buildings (as defined in 6.2.2), or other structures (as defined in 6.2.2). Freeze protection shall be provided for hydronic systems.

3.1.4.3 Thermal energy recovery. Thermal energy (or heat) recovery shall be evaluated for NAS physical facilities whenever there can be shown an availability of excess or wasted energy and the simultaneous need for that energy. The energy savings potential and cost benefits depend primarily upon the number of hours per year that excess energy is available and can be utilized for purposes that would otherwise require the use of additional purchased energy. Recovered energy may be used for conditioning of ventilation air, space heating and service water heating. Design of and considerations (as defined in 6.2.2) for heat recovery systems shall be in accordance with ASHRAE Handbook, Systems Volume. Where the availability of excess energy and the need for that energy are not simultaneous, consideration shall be given to storing excess energy when available and using it at a later time.

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3.1.5 Climatic conditions and interior environments. Climatic conditions and interior environments for national standard and site adapted designs shall be in accordance with FAA-STD-032.

3.2 National codes and industry standards. The design of all new physical facilities and equipment shall, as a minimum, incorporate energy management and conservation measures as prescribed and recommended in nationally recognized codes and industry standards. Expansions to existing physical facilities shall be considered as new facilities. Rehabilitation and modernization projects for existing facilities shall also incorporate energy management and conservation measures prescribed by these codes and standards to the extent they are shown cost effective based on economic analysis. The following are nationally recognized energy codes and industry standards to be applied to FAA physical facilities:

a. ASHRAE Standard 90A;

b. ASHRAE Standard 90C;

c. BOCA Basic/National Energy Conservation Code;

d. CABO Model Energy Code;

e. NEMA MG-10;

f. NEMA MG-11.

3.3 Energy management and conservation measures. The following list identifies energy management and conservation measures that shall be used in the design or evaluated as potential candidates for implementation into designs for new NAS facilities or expansions or modernizations to existing NAS physical facilities. This list is not intended to be comprehensive nor exclude other energy management and conservation measures from evaluation.

3.3.1 Building. Primary consideration shall be given to non-energy consuming or passive energy components and devices.

a. All exterior doors shall be equipped with automatic door closing devices.

b. Vestibules shall be provided at moderately to heavily used exterior doors at manned physical facilities.

c. Vestibules shall be provided at loading dock areas at manned physical facilities where doors open directly into a conditioned space.

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d. The use of air curtain systems and transparent plastic curtain strips shall be evaluated with the consideration of vestibules.

e. Thermal mass shall be considered and shall be in accordance with BIA Technical Notes in Brick Construction, 4 and 4A through 4H.

f. High maintenance dynamic exterior shading devices, such as solar tracking vertical louvers, shall not be used.

g. Consideration shall be given to placing insulation on building exteriors in predominantly southern or warm climate areas.

h. Double reflective roofs with a ventilated space between roofs shall be evaluated to reduce solar gain in unmanned facilities located predominantly in southern and southwestern regions.

i. Glass windows with high heat reflection capability or lower emissivity shall be evaluated.

3.3.2 Illumination.

3.3.2.1 Lamps. Lamps shall be the most efficient type suitable for the application. Consideration shall also be given to the lamp's useful life and its rate of lumen depreciation which affects overall lamp efficiency. Types of lamps shall include, but shall not be limited to:

a. Incandescent;

b. Fluorescent;

c. Mercury vapor;

d. Metal halide;

e. High pressure sodium;

f. Low pressure sodium.

3.3.2.1.1 Safety and security considerations. High efficiency lamps shall be used. Consideration shall be given to the color rendition of the candidate lamps and lighting system. Neither safety nor security shall be compromised by their use.

3.3.2.1.2 Incandescent lamps. The application of incandescent lighting shall be restricted to areas of infrequent and short duration use, such as in janitor's closets and remote unmanned facility toilet rooms. Incandescent lamps shall only be used where clearly shown to be the most cost effective type of lighting for those areas.

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3.3.2.2 Interior lighting. The actual power used for interior lighting shall be as low as practical and shall not exceed 85% of the calculated lighting power budget (as defined in 6.2.2).

3.3.2.2.1 Task lighting systems. Task lighting systems shall be utilized whenever workspaces are designed for specific functions. Task lighting shall be on a separate circuit from the main lighting systems. Task lighting may be integrated in furniture or equipment.

3.3.2.2.2 Natural lighting. Natural lighting shall be utilized whenever feasible. Automatic dimming and switching systems shall be evaluated whenever natural lighting is available. Dimming devices shall be energy savings type. Skylights shall be evaluated as sources of natural lighting. Their use shall be determined by economic analysis and limited to areas not requiring glare-free or low ambient lighting systems.

3.3.2.2.3 Fixtures. Consideration shall be given to mobile fixtures and to fixed fixtures with heat removal capability.

3.3.2.2.4 Controls. Manual and automatic lighting controls shall be provided to avoid unnecessary consumption of electrical energy for lighting. Controls shall include, but shall not be limited to the following as applicable to the specific project:

a. Multiple switching;

b. Dimming devices;

c Key-activated switches;

d. Telephone signal-activated controls;

e. Three way switches;

f. Ballast load switching systems;

g. Door activated controls;

h. Photocell controls;

i. Photocell/timeswitch combination controls;

j. Dimmer/photocell combination controls;

k. Dimmer/timeswitch combination controls;

l. Radio-controlled high pressure sodium ballast system;

m. Personnel detection controls, such as ultrasonic, passive infrared, active infrared, and acoustic;

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n. Centralized programmable lighting control systems.

3.3.2.3 Exterior lighting. Exterior lighting design shall provide safe and secure access to and egress from NAS facilities. Calculations shall include a cost-benefit analysis which compares the higher energy-efficiency/lower first cost for larger fixtures to the higher operational-efficiency and controllability of a greater number of smaller fixtures.

3.3.2.3.1 Excluded areas. Areas specifically excluded from consideration for exterior lighting include landscaping, general architectural lighting, or general site lighting.

3.3.2.3.2 Control. The electrical design shall incorporate sufficient system controls for exterior lighting to ensure energy-efficient operation of the system. System controls shall be both ambient light dependent and time/time-of-day dependent. Exterior lighting circuits shall be divided by lamp type and site vicinity in such a manner as to permit reductions in usable lighted parking zones and walk areas. The design shall provide for conformity to seasonal, occupancy, and shift changes common to the operation of larger manned facilities. For unmanned facilities, exterior lighting shall be controlled by a manually-activated timer switch.

3.3.3 Electric power.

3.3.3.1 Electrical services. Electrical services shall be obtained at the highest, most economically feasible voltage available. Consideration shall be given to power company rate schedules, service and transformer losses and service classifications.

3.3.3.2 Voltage drop and system losses. Voltage drop and system losses shall be minimized.

3.3.3.3 Voltage balance. Voltage imbalance of three-phase power shall be minimized.

3.3.3.4 Power factor correction. Where poor power factor results in a penalty by the utility or where power factor is less than 85%, power factor correction devices shall be evaluated. Economic analyses shall be used to determine the relative cost effectiveness of installing the power factor correction devices at the service entrance or at the individual sources of poor power factor which is the preferred location. Preference shall be given to the use of synchronous motors or to the replacement of large motors with energy efficient motors exhibiting higher power factors. When power factor correction is required, it shall be increased to the most cost effective level.

3.3.3.5 Transformers. The minimum transformer efficiency shall be 94%. The temperature rise for a transformer shall be the lowest available that is economically feasible for the size and type required.

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3.3.3.6 Motors. High efficiency motors shall be used. Single-phase motors shall be selected in accordance with NEMA MG-11. Polyphase motors shall be selected in accordance with NEMA MG-10. Motors shall be sized to handle design loads and designed for the particular environment encountered. Where the motor load varies significantly for extended durations, the use of multiple motors (i.e., a small and a medium size motor) rather than one large motor shall be evaluated. Variable and multispeed motors and motors with variable or multispeed drives shall be evaluated. Variable frequency motor drives shall be utilized to the greatest extent that is economically feasible.

3.3.3.7 Peak load demand shaving. Peak load demand shaving (as defined in 6.2.2) shall be provided, where economically feasible, to reduce the peak demand. Peak load demand shaving techniques shall not adversely affect system reliability or maintainability. Peak load monitoring equipment shall operate in the same time interval as the power company's demand meter and if possible, shall utilize the power company's demand metering pulse.

3.3.3.7.1 Demand shaving techniques. Demand shaving techniques shall be considered, such as transfer of loads from normal power to standby engine generator systems, where available. A life cycle cost (as defined in 6.2.2) analysis shall be performed to determine the most economical engine generator system, gas, diesel, or gasoline. Consideration shall be given to local cost and availability of the various fuel types. Engine generator systems shall be carefully chosen to obtain the most efficient combination possible for the particular size required. Engine and generator efficiencies shall be reflected in the life cycle cost analysis.

3.3.4 Heating, ventilating and air conditioning (HVAC) systems.

3.3.4.1 Distribution. Air and water transport factors shall be the highest, most economical values consistent with ASHRAE Standard 90A. In order to minimize the energy consumed in distributing the conditioned air or thermal fluid, consideration shall be given to, but shall not be limited to the following energy management and conservation measures.

a. Minimize heat transfer through duct and pipes;

b. Minimize the pressure rating of the air handling system;

c. Minimize air/water leakage.

d. Conduct trade-off study between an all-air system versus a hydronic system;

e. Evaluate multiple delivery systems and multiple speed motors on individual fans or pumps for reduced loads or for staging.

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3.3.4.2 Controls. Control systems shall be compatible with the central control monitoring system (CCMS) or the remote maintenance monitoring system (RMMS) and shall be connected to these systems as directed by FAA.

3.3.4.2.1 Direct, indirect and combination controls. When there is a choice between the type of equipment or system controls, direct controls shall be preferred over indirect controls. Where both are used in combination, direct controls, such as a room thermostat, shall override indirect controls, such as a supply temperature controller or outside air reset controller. Except at small and unmanned facilities, modulating controls shall be preferred over on-off or two-position controls.

3.3.4.2.2 Central and localized control. Localized controls shall cause heating or cooling energy to be consumed in proportion to the need. Localized control systems shall be compatible with the central control system. To the maximum extent practicable, all localized controls shall be designed to be overridden by the central control system.

3.3.4.2.3 Dead band control. The dead band temperature difference between the operation of the heating and cooling systems shall be adjustable and shall be set typically where no heating or cooling is provided until the space temperature is outside the specified dead band range provided in FAA-STD-032. Dead band control shall be used with the economizer cycle (as defined in 6.2.2).

3.3.4.2.4 Economizer cycle. Economizer cycle, allowing up to 100 percent outside air into the conditioned space, shall be used where it is cost effective and its use results in energy savings. Economizer cycle may be of the type regulated by outdoor air dry bulb temperature or by total heat content (enthalpy) of outdoor and indoor air. In high humidity areas, the total heat content economizer cycle shall be preferred over the outdoor air temperature type to ensure that additional load is not placed on the air conditioning system. The use of the economizer cycle shall be weighed against its effect upon recoverable heat energy so that useful recoverable heat energy is not arbitrarily exhausted from the conditioned space.

3.3.4.2.5 Load reset control. Load reset control, such as an outdoor air temperature reset control in a hydronic heating system or a room or zone thermostat to override a cooling coil discharge thermostat, shall be used to help reduce energy consumption which may be caused by the use of indirect controls.

3.3.4.2.6 Timed set-back controls. Timed set-back controls such as time-of-day, night, and weekend set-back, shall be used to reduce energy consumption during the period of time when heat or cooling is not needed. Set-back controls shall provide minimum conditioning to maintain set back temperature during non-occupied periods. Timed set back

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controls shall be evaluated to ensure that excessive energy is not consumed during warm-up or cool-down periods to the extent that the benefits to be derived from the controls have been severely curtailed or eliminated.

3.3.4.2.7 Anticipatory controls. Anticipatory controls, such as automatic warm-up or cool-down cycles, shall be used to reduce or otherwise minimize energy consumption. Anticipatory controls shall anticipate the need for heating or cooling cycle so that space conditions will be gradually changed to the desired environment by the time the change is required.

3.3.4.2.8 Chilled water temperature controls. Chilled water supply temperature shall be selected at the highest level possible consistent with room humidity requirements to reduce energy requirements of water chilling equipment. Temperature range shall be maximized to reduce water flow rates and minimize pump energy and power requirements.

3.3.4.2.9 Chilled water flow control. Chilled water systems shall be designed for variable/staged flow to minimize pumping energy and distribution losses. Designs shall provide for minimum flow necessary through water chillers to prevent freeze-up. Two-way modulating control valves shall be used at terminal cooling units.

3.3.4.3 Air filtration. Air filtration efficiency shall be appropriate for the area served and shall be in accordance with the recommendations contained in the ASHRAE Handbook, Systems and Equipment Volumes. Initial and final pressure losses for filters shall be optimized to minimize energy and power requirements for the air handling system.

3.3.4.4 Ventilation requirements. Except with economizer operation, outside air ventilation requirements shall be kept to a minimum but shall neither violate code nor create any unsafe or hazardous conditions. Ventilation requirements shall be in accordance with FAA-STD-032.

3.3.4.5 HVAC system types. The compatibility of the system type and method of control to the area, facility or equipment served shall be of primary consideration in order to avoid unnecessary energy consumption. Upon analyzing the various system types, consideration shall be given to the following energy consumption comparisons.

a. Unitary systems generally consume less energy than central systems;

b. Single zone central systems are generally more efficient than multizone central systems;

c. Induction systems are generally more efficient than all-air systems.

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3.3.5 HVAC equipment.

3.3.5.1 Heating equipment. Heating equipment shall be evaluated on the basis of maximum efficiency over the operating range of the equipment when cost effective.

3.3.5.2 Air conditioning equipment and heat pumps. Air conditioning equipment and heat pumps shall be evaluated on the basis of maximum coefficient of performance (COP) over the operating range of the equipment when cost effective.

3.3.5.2.1 Compressors. Compressors, such as reciprocating and centrifugal, shall be evaluated on the basis of full and partial load performance. The use of hot gas bypass shall be avoided. Variable speed drives and capacity control by adjustable inlet vanes shall be evaluated for partial load conditions.

3.3.5.2.2 Staging and arrangement. The size and quantity of equipment shall be determined from the operational profile of the physical facility. Equipment shall be arranged in series or parallel and shall be staged such that the minimum number of units are operating at or near maximum efficiency to meet the load requirements.

3.3.5.3 Dehumidification equipment. Dehumidification equipment shall be evaluated on the basis of maximum pints of water per hour per input kW.

3.3.5.4 Humidification. Steam humidification boilers shall be evaluated on the basis of maximum efficiency and shall be controlled by room sensor. The room sensor shall shutdown the boiler when there is no demand for humidification.

3.3.6 Service (domestic) hot water systems.

3.3.6.1 Storage capacity and recovery rate. Except for energy demand control, the storage capacity and recovery rate shall not exceed the design demand load requirements. Storage tank and equipment shall be insulated. Storage tank water temperature shall be kept as low as practical within code. Storage tank water temperature shall not exceed 105°F.

3.3.6.2 Distribution. Hot water distribution may be by direct discharge (non-recirculating) or recirculating. All piping shall be insulated.

3.3.6.2.1 Recirculating pump. The selection of the recirculating pump shall be based upon optimization of minimum horsepower and maximum efficiency. Pump operation shall be automatically controlled by timer or aquastat.

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3.3.6.2.2 Recirculating versus non-recirculating. A trade-off study shall be conducted to determine which system results in the minimum energy consumption, including pump energy and heat losses.

3.3.6.3 Dishwasher hot water supply. Dishwasher hot water supply shall be independent from domestic hot water system where practical. The use of electric booster heaters shall be avoided; where necessary limiting controls shall be evaluated to avoid excess peak electric power demand. Consideration shall be given for dishwashers designed specifically for use with normal (105°F) domestic hot water temperature.

3.3.6.4 Energy demand control. Consideration shall be given to increased storage and reduced recovery rate of electric water heaters for electricity demand control, particularly where the service water heating energy requirements exceed 20 kW. The same principle shall apply to gas-fired water heaters subject to penalties for gas consumption under interruptible service conditions.

3.3.6.5 Fixtures. Fixtures shall be water-saver type with flow restrictors and automatic shut-off features. Fixtures shall not be a nuisance to the user which may result in overuse and defeat the purpose of its special design feature.

3.3.7 Process equipment. Process equipment energy is that which is consumed for purposes other than for comfort conditioning and illumination. In NAS facilities this equipment is largely comprised of navigation, communication, surveillance, and other electronic equipment as well as data processing equipment. Energy management and conservation requirements for this type equipment are provided in facility development specifications for each subsystem or project.

3.3.7.1 Heat recovery. Since process energy consumption normally results in additional energy requirements imposed on building environmental control systems, these systems must be examined (as defined in 6.2.2) for potential energy management and conservation measures. In particular, these systems shall be evaluated for energy recovery for preheating ventilation air or heating adjacent spaces.

3.3.7.2 Equipment enclosures. Equipment enclosures (as defined in 6.2.2) shall be evaluated as an energy management and conservation measures for electronic process equipment in unmanned facilities. The enclosure would provide a means to condition the minimum volume necessary to house and access the equipment for maintenance. Work areas outside the enclosures would then be designed for broad dead band temperatures.

3.3.8 Thermal energy recovery. Thermal energy (heat) recovery shall be evaluated for physical facility equipment and systems. In particular, consideration shall be given to recovery of excess energy from power conditioning equipment for heating adjacent battery rooms, engine generator rooms and other ancillary spaces.

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3.3.9 Energy and load management. Energy management and control systems designed to reduce energy use or reduce energy costs shall be evaluated for use at NAS physical facilities. Energy management and control systems shall be evaluated for control throughout the physical facility, control of a group of systems or devices, or control of an individual device or system.

3.3.9.1 Localized energy management and control systems. Localized energy management and control systems provide independent, relatively low cost control for specified systems and equipment. Each local controller is independently controlling its specified system or equipment and without acting in conjunction with any other controlling device. Localized energy management and control systems include time controls, automatic temperature setback/setup controls, economizer cycle controls, supply temperature reset controls and dead band controls.

3.3.9.1.1 Dead band control system. A dead band control system operates solely on the basis of room temperature. It establishes a relatively wide range (dead band) over which no heating or cooling is provided. As the temperature falls below or rises above dead band settings, heating or cooling is gradually increased. A space demand reset control is provided which uses space temperature to automatically readjust the temperature of the air being supplied to heat or cool the space. A dead band control is applicable to HVAC systems which provide heating and cooling in sequence; it can be used effectively even when these systems have economizer cycle controls or are interfaced with higher levels of energy management control systems.

3.3.9.1.2 Chiller energy management controller. A chiller energy management controller uses programmed logic to load, unload, start, and stop centrifugal chillers. The controller also resets suction temperature automatically by sensing load requirements; remotely monitors and displays inlet vane position in percentage, as well as chiller operating hours; and starts the standby chiller automatically, when needed.

3.3.9.2 Remote limited and multifunction energy management control system. Remote limited and multifunction energy management control system devices are typified by a limited function demand controller, which interfaces with numerous energy consuming devices and systems to limit electrical demand. Energy management control system devices are programmable through use of microprocessors and provide for multifunction capability in a common enclosure. Remote limited and multifunction energy management control system devices usually are most applicable when the functions to be performed are limited, and there are fewer than one hundred (100) points to be monitored and controlled.

3.3.9.2.1 Demand controller. A demand controller prevents electrical demand from exceeding a predetermined maximum. Certain interruptible non-critical or secondary loads are connected to it. As usage approaches

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maximum during an interval, secondary loads are shed. When usage subsides, or when the demand interval ends, the secondary loads are restored. Demand controllers shall be designed to contend with present utility rate structures and metering methods and to adjust to changes that might be imposed by utilities. Demand controllers shall be designed so as not to interfere with essential facility operations.

3.3.9.3 Centralized computer-based energy management control system. A centralized computer-based energy management control system comprises a microcomputer or minicomputer to monitor and control various points. Man-machine interface usually occurs in a master control room which contains various operator consoles. In some cases the computer and support devices are remote with data generated in the building being transmitted to the computer via leased telephone lines. Centralized computer-based systems usually are appropriate when:

a. Optimization functions are needed;

b. Control decisions are to be based on the number of parameters and conditions involved, and on the series of events which occur;

c. There are 200 or more points.

3.3.9.3.1 Chiller optimization. Chilled water optimization shall be evaluated for chilled water plants with multiple chillers. The optimization program selects the chiller or chillers required to meet the load with minimum energy consumption. System incorporates interlocks with chilled water pumps, condenser water pumps and automatic valves for isolation of non-operating pumps and chillers.

3.3.9.3.2 Chilled water temperature reset. Automatic chilled water temperature reset shall be evaluated to reduce energy input per ton of refrigeration. Chiller discharge temperature is reset upward during non-peak periods to the maximum which will satisfy space cooling and dehumidification requirements. The chilled water temperature is reset upward until the required space temperature or humidity can no longer be maintained. This determination is made by monitoring positions of chilled water valves on various cooling systems or by monitoring space temperature and humidity conditions.

3.3.10 Other energy management and conservation measures. Other energy management and conservation measures shall be identified and evaluated to determine potential candidates for implementation into designs for new facilities or expansions or modernizations to existing physical facilities. The following referenced documents shall be used for identifying potential energy management and conservation measures for evaluation. Only those measures applicable to NAS physical facilities shall be considered.

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DOE/CS-0132	Architects and Engineers Guide to Energy Conservation in Existing Buildings
DOE/CS-0133	Identifying Retrofit Projects for Buildings
GSA	Energy Conservation Guidelines for Existing Office Buildings
GSA	Energy Conservation Guidelines for New Office Buildings
EEI	Energy Management Handbook

3.4 Energy consumption baseline and profile. An annual energy consumption baseline (as defined in 6.2.2) of all candidate energy sources under consideration shall be developed in accordance with ASHRAE 90C. The annual energy consumption baseline shall be provided for each new building or new energy consuming mechanical or electrical system, whichever represents the major design. All non-major design items shall be incorporated within the overall major design for the purpose of developing the annual energy consumption baseline. Energy units and conversion factors shall be as provided in 10 CFR 436, Subpart C. Preference shall be given to the utilization of alternative/renewable energy sources. Energy consumption baseline and profile shall include process energy required to power electronic equipment. The analysis shall clearly differentiate between the energy reduction attributed to the use of electronic equipment and the amount saved by energy management and conservation measures for the physical facilities.

3.4.1 National standard design. Energy consumption baselines shall be developed using the highest summer and lowest winter temperatures provided in the table of summer and winter climatic zones (as defined in 6.2.2) in FAA-STD-032 for each summer and winter climatic zone.

3.4.2 Site adapted design. An hour-by-hour fuel and energy consumption profile (as defined in 6.2.2) for each energy consuming system shall be developed for the hottest and coldest days and for a design summer (2-1/2 percent column) and winter (97-1/2 percent column) day for the location under consideration. Each profile shall be for a 24-hour period starting at midnight and shall include each candidate energy source under consideration and the overall sum total of these sources. When specified in an FAA engineering requirement, task order, or NAS subsystem or project specification, an hour-by-hour fuel and energy consumption profile shall be developed in the manner cited above for 8760 hours per year.

3.5 Economic analyses.

3.5.1 General. Unless otherwise stated, energy management and conservation measures for design or retrofit shall be analyzed for maximum cost-effectiveness. The type of economic analyses (simple payback or life cycle cost) shall be as provided in FAA engineering requirement, task order or system or subsystem specification. Where implementation of energy management and conservation measures is made

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from selections based upon different types of economic analyses, life-cycle cost analysis (LCCA) shall be performed on all such energy management and conservation measures. The economic life of physical facilities is provided in FAA-STD-032.

3.5.2 Exceptions. For new physical facilities economic analyses will not be required for energy management and conservation measures imposed by national codes and industry standards.

3.5.3 Standard. Standard economic analyses shall be in accordance with 10 CFR Part 436, Subpart A. The energy management and conservation measures under analyses shall pass the presumption test under Section 436.13 of 10 CFR Part 436, Subpart A, prior to assessing cost effectiveness.

3.5.3.1 Economic feasibility.

3.5.3.1.1 Estimated simple payback time. Except for alternative/renewable energy source conservation measures, an energy management and conservation measure shall be considered economically feasible if its estimated simple payback time is less than or equal to six years.

3.5.3.1.2 Life cycle cost analyses. Except for alternative/renewable energy source conservation measure, an energy management and conservation measure shall be considered economically feasible if its savings-to-investment ratio (SIR) is greater than or equal to one.

3.5.3.1.3 Alternative/renewable energy sources. The test for economic feasibility and other economic factors for analyses of energy management and conservation measures involving use of alternative/renewable energy sources will be provided by FAA.

3.5.4 Analyses of multiple energy management and conservation measures. The cumulative effect of implementing more than one energy management and conservation measure shall be taken into account by using this or an equivalent procedure subject to FAA approval:

a. Calculate the energy savings on all energy management and conservation measures.

b. Rank the energy management and conservation measures in order of decreasing SIRs or increasing estimated payback time, depending upon the type of economic analysis being used.

c. Starting with the most cost-effective energy management and conservation measure as ranked above, reduce the total energy use (Btu or kWh) by the amount of energy it conserves. This result, i.e., the reduced total energy use, becomes the basis for the calculation for the second ranked energy management and conservation measure.

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d. Continue successively in the same manner with each energy management and conservation measure until the calculations have been done for all ranked energy management and conservation measures.

e. Recompute the SIR or estimated simple payback times based upon taking the cumulative effect into account by using the successively reduced calculated total energy use.

3.5.5 Computational requirements. NBS Handbook 135 and Office of Management and Budget Circular A-94; which contains economic data, worksheets, computer programs, discount rates and methods; shall be used with 10 CFR 436, Subpart A.

3.6 Selection and implementation of energy management and conservation measures. Unless otherwise directed by FAA, all energy management and conservation measures shall be implemented into the design in the following order of preference within the constraints of construction time and budget:

a. imposed national code and industry standard energy management conservation measures

b. ranked in order candidate energy management and conservative measures

Whenever the estimated simple payback times or the SIRs of two energy management and conservation measures are within 10 percent, preference shall be given to the design feature exhibiting the greater energy savings which exceeds by at least 5 percent the energy saving of the energy management and conservation measures with the lower estimated simple payback time or higher SIR provided that reliability is not compromised by the more favorable energy conscious selection.

3.7 Quality assurance requirement. All designs implementing energy management and conservation measures for new physical facilities and modifications to existing physical facilities shall be in accordance with FAA-STD-032 and shall meet national and regional standards for construction, operation and maintenance and shall be subject to the scrutiny of the Joint Acceptance Inspection. Tests shall be conducted to ensure the validity of design or economic analysis techniques which have not been proven by previous application.

3.7.1 Internal design review. The architect or engineer (A/E) shall continually monitor and fully coordinate all assessments, economic analysis, designs, site inspections, site investigations, reviews and document preparation efforts. Preparation of specialized portions of designs shall be accomplished, or supervised by, and certified by experienced persons having state registration in the applicable field. Original tracings of all drawings, the first page of all specifications,

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estimates, and similar deliverables shall be certified and signed by the A/E. The signature shall appear under the A/E's printed name and over the affixed replica of the professional seal or registration certificate number. Unless otherwise waived by FAA, each deliverable item requiring signature shall bear the signature of the registered professional person of the respective disciplines as applicable: civil, structural, architectural, mechanical, and electrical. In addition all structural calculation sheets, divisions, and other structural documents shall have the signature and seal of a professional structural engineer. The requirement for signatures by registered professional structural engineers will not be waived.

3.7.1.1 Seismic Zone IV. All structural documents prepared for Seismic Zone IV shall be sealed by a registered structural engineer from a state in which the facility will be located.

3.7.1.2 Unique design techniques. The A/E shall conduct such tests as are necessary to ensure validity of design techniques which have not been proven by previous application. The A/E shall prepare and submit reports on findings.

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4. QUALITY ASSURANCE PROVISIONS

This section is not applicable to this standard.

5. PREPARATION FOR DELIVERY

This section is not applicable to this standard.

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6. NOTES

6.1 Additional data required. Attention of procurement request initiators is invited to the items listed below which should be covered in the system/subsystem or engineering services specification or contract schedule.

6.1.1 General requirements. Specifications should not categorically impose all requirements of this standard. Only those requirements which are applicable to the specific project should be imposed. Identify FAA system/sub-system or equipment to be served by the physical facility. Specify the deliverables. Specify those energy management and conservation measures that should not be considered or evaluated. Specify any deviations from this standard (3.1).

6.1.2 Alternative/renewable energy sources. Provide direction to A/E on the implementation or evaluation of alternative/renewable energy sources. Provide economic incentive factors (if any) and other relevant economic data for economic analysis. Provide direction for disposition of these energy management control systems when alternative/renewable energy sources are determined not to be ecomonically feasible (3.1.4.2 and 3.5.3.1.3).

6.1.3 Facility occupancy. Specify facility human occupancy, i.e., number of persons, specific work areas, duration of work periods, level of activity, etc. for A/E determination of environmental requirements and automatic controls (3.3.2.2.1, 3.3.2.2.4 and 3.3.4.2.6).

6.1.4 Electric power demand control. Specify interruptible non-critical and secondary loads that may be connected to the demand controller. Specify essential facility operations which are not to be interfered with (3.3.3.7 and 3.3.9.2.1).

6.1.5 Controls connected to the CCMS or RMMS. Specify whether or not controls shall be connected to the CCMS and RMMS and indicate compatibility sequences of these controls (3.3.4.2).

6.1.6 Process equipment. Specify energy management and conservation requirements for process equipment (i.e., navigation, communication, surveillance, and other electronic and data processing equipment) (3.3.7).

6.1.7 Site adapted designs. Specify when an hour-by-hour fuel and energy consumption profile shall be developed for the entire 8760 hours in a year (3.4.2).

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6.1.8 Economic analysis Specify the type of economic analyses, i.e., estimated simple payback period or life cycle cost analysis. Specify any exceptions to the maximum payback period or minimum saving-to-investment ratios which are imposed herein (3.5.1).

6.1.9 Selection and implementation of energy management and conservation measures. Specify deviations from standard. Provide constraints including construction time and budget (3.6).

6.1.10 Preparation for delivery. Specify requirements for deliverables, and post design delivery requirements, if any. Indicate if signature of registered professional person is waived (3.7.1).

6.2 Acronyms, abbreviations and definitions.

6.2.1 Acronyms and abbreviations. The following are definitions of acronyms and abbreviations used in this standard.

A/E	Architect/Engineer
ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning Engineers
ATC	Air Traffic Control
BIA	Brick Institute of America
BOCA	Building Officials and Code Administrators
Btu	British Thermal Unit
CABO	Council of American Building Officials
CCMS	Central Control Monitoring System
CFR	Code of Federal Regulations
COP	Coefficient of Performance
DOE	Department of Energy
EEI	Edison Electric Institute
°F	Degrees Fahrenheit
FAA	Federal Aviation Administration
GSA	General Services Administration
HVAC	Heating, Ventilating, and Air Conditioning
kW	kilowatt
kWh	kilowatt Hours
LCCA	Life Cycle Cost analysis
NAS	National Airspace System
NBS	National Bureau of Standards
NEMA	National Electrical Manufacturers Association
RMMS	Remote Maintenance Monitoring System
SIR	Savings-to-Investment Ratio

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6.2.2 Definitions.

6.2.2.1 Alternative energy sources. Alternative energy sources are those which are neither strictly classed as renewable nor non-renewable. The sources include thermoelectric generators, fuel cells, and thermionic generators, etc.

6.2.2.2 Climatic zone. A geographic area with a defined range of summer and winter conditions. Climatic zones are further defined in FAA-STD-032.

6.2.2.3 Consider. The word "consider" and all derivations, such as "consideration" and "shall be considered" mean that a candidate energy management and conservation measure is to be evaluated and analyzed for technical merit, practicality, and economic feasibility. "Consider" does not mean to give a candidate measure a passing thought, but rather, to perform an indepth analysis on it and include the analysis in the report.

6.2.2.4 Energy consumption baseline. An energy consumption baseline is a tabulation of the estimated quantities of fuel and energy sources required to meet the needs of a new or modified physical facility. The tabulation can be for hourly, daily, or annual energy consumption as needed to fulfill the requirements of the task. Energy consumption baselines can be provided for national standard and site adapted designs and are based upon specified interior/exterior conditions. The information may be used in FAA's energy management reporting system as reference data.

6.2.2.5 Energy consumption profile. An energy consumption profile is similar to an energy consumption baseline, except that the profile is based upon hourly changes in the interior/exterior conditions. An energy consumption profile can be developed for a 24-hour period or the entire year (8760 hours). Profiles can only be developed for site adapted designs and may also be used as a data reference by the FAA in its energy management reporting system.

6.2.2.6 Energy management and conservation measure. An energy management and conservation measure is a means or method which is primarily intended to reduce energy consumption, or to result in reduced energy consumption or to allow the use of alternate and renewable energy sources.

6.2.2.7 Evaluate. For words such as "evaluate", "evaluation", and "shall be evaluated", see "consider".

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6.2.2.8 Economizer. Economizer or economizer cycle is a process in heating, ventilating and air conditioning whereby outside air is used to condition the interior space rather than using the mechanical systems except fans. Economizer cycle is used under specific temperature and humidity ranges and is employed to save energy.

6.2.2.9 Examine. Examine means to consider for technical merit.

6.2.2.10 Fuel cell. A fuel cell converts energy generated by chemical reaction into electrical energy. Its function is similar to a battery except that the chemicals generally are supplied from outside the cell.

6.2.2.11 Life cycle cost. Life cycle cost means the total costs of owning, operating, and maintaining a building over its useful life, including its fuel and energy costs, determined on the basis of a systematic evaluation and comparison of alternative building space-conditioning systems, except that in the case of leased buildings, the life cycle cost shall be calculated over the effective remaining term of the lease.

6.2.2.12 Lighting power budget. A lighting power budget is the upper limit of power to be available to provide the lighting needs in accordance with criteria and calculation procedures provided in ASHRAE 90A.

6.2.2.13 Non-renewable energy source. Non-renewable energy source refers to resources such as fuel oil, gasoline, natural gas, liquified petroleum gas, coal, and purchased steam or electricity generated from such resources.

6.2.2.14 Peak load demand shaving. Peak load demand shaving is a process by which electric loads are shed or transferred to standby generator power in order to reduce electric utility power charges which are imposed for dramatic increases in power consumption.

6.2.2.15 Photovoltaic. A photovoltaic system converts sunlight directly into electricity.

6.2.2.16 Physical facility. The total plant required for a subelement or subsystem to function. The physical facility will house, support or protect the subelement or subsystem at a particular geographic location. The physical facility will have various physical characteristics in accordance with the function of the subelement or subsystem. The physical facility can be of the following types depending on the required function:

a. Building - Consists of walls and a roof either single story or multi-story constructed of various material; usually fixed in location and housing personnel and equipment. The building may include air conditioning, power, etc., if required for the particular application.

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b. Structure - Composed of interrelated parts which together form a structural entity, usually fixed in location containing equipment and which may be manned or unmanned. The structure may include air conditioning, power, etc., if required for the particular application.

c. Enclosure - Interrelated parts which surround or shut in equipment, fixed or movable, usually unmanned. The enclosure may include air conditioning, power, etc., if required for the particular application.

6.2.2.17 Requirement. A specified capability which must be provided by the system, subsystem, end item, contractor, etc. Type of requirements include operational, functional, performance, interface, facility, and verification requirements.

6.2.2.18 Renewable energy source. Renewable energy source refers to resources such as sunlight, wind, geothermal, biomass, solid waste, or other regenerating sources.

6.2.2.19 Solar energy. Energy derived from the sun directly through the solar heating of air, water, or other fluids, by electricity produced from solar photovoltaic or solar thermal processes, or indirectly from the use of wind, biomass or small scale water power.

6.2.2.20 Thermoelectric generators. Thermoelectric generators convert heat energy directly into electricity by using the thermocouple principle. They may be fossil-fueled or radioisotope-fueled.

6.3 Suggested computer programs. Computer program software may perform peak load calculations and the hour-by-hour calculations consistent with this standard. Computer analyses may be used to aid the designer in calculating energy loads, energy consumption, highlighting energy end losses, selecting the best HVAC equipment, sizing equipment capacity for efficiency and economy, and testing effectiveness of differing building characteristics, orientation, and exterior environments as described in this standard. Computer analyses and computer-aided design may be used whenever LCCA will be applied to the design options. Below is a list of suggested software. The list is by no means complete and the A/E is urged to use other programs subject to approval by FAA.

a. Solar

Name	Source
SOLCOST	Control Data's CYBERNET Services

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b. Building form, exterior and interior

Name	Source
ECUBE 75	Control Data's CYBERNET Services
SUNSET	Dubin - Mindell - Bloome Associates
Glass Comparison	Libbey-Owens-Ford
ARK-2	Perry, Dean & Stewart
B.O.P.	Skidmore, Ownings & Merrill
CCB/CALERDA	Control Data's CYBERNET Services

c. Heating, Ventilating and Air Conditioning

Name	Source
ECUBE 75	Control Data's CYBERNET Services
NBSLD	Control Data's CYBERNET Services
BLAST	U. S. Army Construction Engineering Research Laboratory at Campaign, Ill.
CCB/CALERDA	Control Data's CYBERNET Services
HCC-III (Mini-Deck)	APEC
Equipment Selection	Trane Co.
Duct Program	APEC
Several	Dalton, Dalton, Little & Newport
Several	Giffels Associates, Inc.
Fan Static Calculations	Giffels Associates, Inc.
Energy Calculations I & II	ASHRAE Publications Sales Department

d. Domestic Water Piping Design

Name	Source
Piping Program	APEC
Several	Dalton, Dalton, Little & Newport
Several	Giffels Associates, Inc.

e. Lighting

Name	Source
Lighting II	APEC
Lighting	Dalton, Dalton, Little & Newport
Interior Lighting Analysis & Design	Giffels Associates, Inc.
Lighting Program	Isaac Goodbar
Lighting Program	Illumination Computing Service
Lighting Program	Ian Lewen
Lumen II	Smith, Hinchman & Grylls
Day lighting	Libbey-Owens-Ford

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f. Electrical Demand

Name	Source
Electrical Demand Load Study	Giffels Associates, Inc.

g. Energy Audit and Baseline

Name	Source
Energy Programs (EP)	Control Data's CYBERNET Services

h. Energy Audit and Life Cycle Cost Analyses

Name	Source
Energy Analyst	American Energy Services, Inc.

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