Note: **This document is no longer applicable to Navy projects. Federal Regulation 10CFR435 has been rescinded and has been replaced with 10CFR434. This new regulation, which became effective 8 October 2001, requires compliance with ASHRAE Standard 90.1. New NAVY criteria has been adopted to conform with this requirement. Pleae see the Mechanical Engineering Design Guide for further information.**

CHAPTER 8

ENERGY CONSERVATION CRITERIA

A. PURPOSE.

1. General. This chapter establishes standards and minimum criteria to ensure that energy conserving designs are developed for new construction and major renovation projects for facilities on DOD installations. Energy conservation features required in other chapters of this document will be incorporated into project designs, using appropriated funds, unless Life Cycle Cost Analysis (LCCA) calculations indicate that other alternatives are more effective.

2. Renovations. Major renovation is defined as changes in the functional use of the building, reconfiguration of interior partitions and reallocation of spaces, changes in the features of the building envelope and replacement of lighting, HVAC and water heating systems. Unless programmed and funded to upgrade the facility to new building energy conservation levels, major renovation projects are exempt from compliance with Energy Use Budget, Active Solar Analysis and Special Studies requirements stated hereafter. All building components and systems being renovated or replaced shall comply with their respective energy conservation criteria and be evaluated using economic criteria provided in he National Bureau of Standards Handbook 135 (reference (8a)).

3. Minor Repair and/or Replacement. Minor repair and/or replacement of windows, doors, lighting fixtures, HVAC equipment and water heating equipment in existing systems shall comply with the energy conservation criteria only to the extent of the items being replaced. Other portions of the existing system(s) not affected by these replacements are exempt from these criteria.

B. GENERAL REQUIREMENTS.

1. References. Many of the provisions in these criteria, including compliance with the design energy targets shown in Table 8-1, are mandatory and predicated on Title 10 CFR, Subpart A, Part 435, "Energy Conservation Voluntary Performance Standards for new Commercial and Multifamily High Rise Residential Buildings, Mandatory for Federal Buildings," published January 30, 1989 (reference (8b)), the Federal Energy Management Improvement Act of 1988 (reference (8c)), and Department of Defense Energy Target requirements.

2. Application. Occupant comfort and productivity, and other functional requirements of the building will not be adversely affected by any energy conservation

Attachment B-1

measure. In the process of satisfying these functional requirements, designs will include the least complex, life cycle cost effective, energy conservation measures required to meet the design energy target (DET).

3. Energy Source Selection. Energy source selection will be as defined in Chapter 11.

4. Energy Calculation Method.

(a) All energy calculations for any new building that is heated only or heated and/or air conditioned and exceeds 3,000 sq. ft. of gross floor area will be calculated using a professionally recognized and proven computer program or programs that integrate architectural features with air-conditioning, heating, lighting, and other energy producing or consuming systems. These programs will be capable of simulating the features, systems, and thermal loads used in the design. Using established weather data files, the program will perform 8760 hourly calculations. The Building Load Analysis and Systems Thermodynamics (BLAST), DOE 2.1C and BESA (Canada) energy analysis programs are recognized by 10 CFR part 435 Subpart A as acceptable programs for these purposes. Programs that "condense" the weather files and number of calculations into several "typical" or average days per month or follow modified bin calculation procedures may be used when the features or complexity of the building design do not demand the 8760 hourly calculations to give accurate results.

(b) Energy calculations for buildings not required to use computer programs may be performed using a computer program as defined above or the Simplified Multiple-Measure Methods describe din Chapter 28, "Energy Estimating Methods" of the ASHRAE, Handbook of Fundamentals (reference (8d)).

5. Meters. A utility meter shall be furnished at each building for each utility serving the building (e.g., steam, high temperature hot water, electricity, natural gas, fuel oil, etc.) in the normal units of the utility (i.e., kWh, cf, gallons, etc.) to allow determination of energy consumption.

C. PROCEDURES FOR THIRTY-FIVE PERCENT DESIGN. The procedures given below are required to ensure that designs comply with federal energy conservation criteria and incorporate functional cost effective energy conservation alternatives.

1. Compliance. The design shall comply with all minimum energy conservation standards that are prescribed in this handbook, guide specifications, and other design criteria. Thermal transmittance of envelope elements may be based upon the "U" factors contained in Table 8-4. These "U" factors are optional except as indicated in the footnotes.

2. LCCA Calculations. Computer calculations will be performed using the Life Cycle Cost In Design (LCCID) computer program or a program determined to be

equivalent. The energy to be considered will include all known thermal loads including process, ventilation, and occupant loads. Operating hours will be those actually anticipated for operation. Consider and evaluate the most practical and least complex alternatives required to meet the design energy budget. Place emphasis on the use of passive features (e.g., insulation, orientation, etc.) vice active systems (e.g., heat recovery, co-generation, etc.) to obtain the design energy target. For each analysis the least complex alternatives that meet the design energy target at the lowest life cycle cost (LCC) will be incorporated into the design.

(a) All economic analysis will use the fuel price escalation rates published by the National Institute of Standards and Technology (NIST) (reference 8a)) for the Industrial Sector in effect on the date of the study. Energy analysis tools used with the LCC calculations shall conform to paragraph B.4 above.

(b) During periods of rapid change in fuel prices the average local fuel price for the previous 12 month period should be used in the analysis in lieu of the current contract price.

(c) In lieu of performing project specific individual economic studies, the designer may select alternatives on the basis of previous economic analysis or generic studies provided these studies are applicable to the project under design.

(d) In all cases, the essential elements of the design selection process including, as a minimum, the basis for which the list of feasible alternatives was developed and the basis upon which the various design decisions were reached, will be documented in the design analysis and retained in the project file.

3. Active Solar Analysis.

(a) The economic feasibility of incorporating an active solar domestic water preheating system will be evaluated using the Solar Feasibility (SOLFEAS) computer program or one determined to be equivalent. Economic evaluations of solar space heating and cooling systems are not justified at this time. In lieu of a separate SOLFEAS analysis, previous SOLFEAS analyses for similar facilities, climatic regions and sized systems, updated to current economic conditions, may be used. If the SOLFEAS or the generic study indicates the active solar system to be feasible, the system will be compared to the most life cycle cost effective design without consideration of the active solar system.

(b) The Savings to Investment Ratio (SIR) and the discounted payback period will be calculated. If the SIR for the active solar system is greater than one it will be included in a revised design as an optional additive feature. Additional funds required for the active solar system will be a separate line item on the concept cost estimate.

4. Design Energy Target (DET) Compliance Check.

(a) All new facility designs having a process energy load exceeding 60 percent of the calculated total peak heating and/or cooling load are exempt from the DET compliance check. Process energy load is energy consumed or produced by or in support of functional processes performed in a building. Examples of process energy loads are: energy required to temper outside air for ventilating paint spray booths or kitchen hoods; electrical energy consumed by personal computers and other non-real property installed equipment, or user equipment, and the cooling energy associated therewith; service water heating for vehicle wash stations; and energy consumed to heat vehicles to space temperature in service bays.

(b) The appropriate DET will be determined from Table 8-1 utilizing the weather regions of Table 8-3 and the facility types of Tables 8-5. A compliance check will be conducted to verify that the Design Energy Budget (DEB) is within the DET.

(c) Each design will have a unique calculation performed to determine the DEB utilizing the fuel conversion factors of Table 8-2. The expected nonprocess energy consumed for the health, comfort, and productivity of occupants (such as air-conditioning, heating, humidification, task and general lighting, ventilation, and service hot water) will be included. The operating hours will be the "HOURS PER DAY" and "DAYS PER WEEK" values given in Table 8-1 for the facility type. Process loads will not be included. Sensible and latent loads of people are non-process and will be included. The annual energy contribution from non-purchases renewable energy sources, such as from active solar systems, will not be included.

(d) If the DEB is less than or equal to the DET the design complies with this criteria. If the DEB exceeds the DET, the design will be revised to incorporate other economically justified energy conservation measures that may not have been considered before. The DEB will then be recalculated. If the DEB still exceeds the DET, a request to waive this criterion will be forwarded to the appropriate engineering field office for consideration. A detailed analysis of the problem complying with the DET will be provided. The waiver may be granted or further changes directed in the design to gain compliance.

D. FINAL DESIGN PROCEDURE. The LCCA for the 35 percent design will be reviewed and revised as necessary. Any energy conservation feature identified during final design and not addressed in the 35 percent design analysis will be analyzed. (All re-design costs associated with incorporating the new feature will be included in the analysis). If the new feature is found to be cost effective, the 35 percent design including LCCA, and calculation of the DEB, will be revised accordingly and the feature incorporated into the design. If the final design includes the optional active solar energy domestic hot water preheating system, the advertising documents will include this feature as a contract additive. This additive will be awarded in the contract if the funds requested in the concept estimate have been provided and the feature continues to have an SIR greater than one as bid.

E. SPECIAL STUDIES.

1. Photo voltaic. A photo voltaic power generation study comparing the "baseline" design with prospective photo voltaic applications will be performed for applicable projects. Such projects include cathodic protection of pipelines, cathodic protection of bridges and water towers, data links, emergency, and rescue communications, lighting, load center power, marking and warning devices, military range monitoring and conditioning equipment, monitoring and sensing devices, navigational aids, perimeter security devices, remote communication sites, remote instrumentation, remote weather stations and transmitters, repeater stations, and water pumping and purification.

2. Wind Energy Conversion Systems (WECS). The use of wind power should be considered only if an evaluation demonstrates that a sufficient mean annual wind exists for WECS to economically meet all or a significant fraction of the load demand. The most economical application of WECS is the generation of electricity using small wind turbine generators, with or without storage, located at remote sites. The lack of a demonstrated reliability of these machines to date indicates that extreme caution should be used before application, especially for critical loads at remote sites. Also, cost projections for maintenance and repair are critical items in the economic analysis.

3. Geothermal Energy. The use of geothermal energy should be considered in areas of proven reserves or in areas that have a high potential for geothermal resources.

Table 8-1
Design Energy Targets (DET)

FAC TYPE	WEATHER REGIONS											HRS PER DAY	HRS PER WEEK
	1	2	3	4	5	6	7	8	9	10	11		
A1	55	55	45	45	45	45	40	35	35	40	40		
A2	45	45	40	40	40	40	35	35	30	35	35	10	5
B	145	135	135	135	135	135	105	100	100	105	110	24	7
C	55	45	45	45	45	45	35	35	35	35	35		
D	70	65	65	65	65	65	55	50	40	45	60	10	5
E	70	65	65	65	65	65	50	45	35	40	55		
F	60	60	55	55	50	50	45	45	40	45	50	24	7
G	85	80	75	70	65	60	50	35	35	45	50	10	5
H	85	75	65	60	60	55	45	40	30	35	45	24	7
I	85	75	65	60	60	55	45	40	30	35	45	10	5
J	80	70	65	60	55	55	45	40	35	40	40		

Table 8-1 (Cont)
Design Energy Targets (DET)

K	60	60	55	55	50	50	50	40	40	45	50		
L	70	70	70	65	65	65	65	60	55	65	65	16	7
M	65	65	60	60	55	55	50	50	45	50	50	8	7
N	70	70	65	65	65	60	60	55	55	65	70	16	7
O	60	60	55	45	40	40	35	25	25	25	30	3	5
P	60	60	55	45	40	40	30	25	20	20	25	10	5
Q	70	65	60	55	55	45	45	45	40	45	50	16	7
R	75	65	65	55	55	50	40	35	25	30	45		
S	55	50	45	40	35	25	20	15	15	20	20	24	7
T	45	65	70	80	85	85	85	80	70	75	90		
U1	105	95	85	80	80	75	65	55	50	70	70		
U2	90	80	70	65	65	60	50	50	45	50	60	24	6
V	100	95	85	80	80	70	65	55	55	55	65	12	6
W	95	95	80	75	65	60	55	45	40	45	55	10	5
X	35	30	30	25	25	20	20	20	15	20	20	24	7

1. The DEB's and DET's are not intended to be used to predict actual energy consumption for the completed facility. They are only guidelines for determining the relative energy consciousness of energy alternative models. Used in this context, a building design that complies with its DET, all other things equal, will very likely consume less energy than one that does not.

2. The DET, given in 1,000 Btu / ft2 / yr (2,523.3 kg calories / m2 / yr), pertains to the energy consumed by buildings within the 5-ft (1.5m) line of the building with the following exceptions:

(a) The energy required to operate energy plants, systems, and equipment (including distribution system losses and gains) which rest outside the 5-ft (1.5-m) line, and which serve a single building (e.g., remote packaged chiller, cooling tower, substation or heating plant) will be included, in total, in the calculated DEB of the building.

(b) The energy furnished by plants, in the form of steam, high or medium temperature hot water, or chilled water which serve more than one building shall be included in the DEB calculation. Credit will be taken for energy content of condensate or water returning to the central plant. Energy losses and gains from the distribution system between the plant and the buildings, as well as the energy conversion losses of the plant itself (other than that taken into account in the fuel conversion factors table) will not be included in the DEB of the connected buildings.

3. If another distinct function, facility type, is being performed in an area which comprises 10 percent or more of the building's gross floor area, the DET will be normalized by using the following formula:

DET = DET (Area = 1 / AreaT) + DET2 (Area2 / AreaT) + ..+ DETN (AreaN / AreaT)

Where: DET is for the mixed use building,
DETN is for one of the distinct functional areas,
AreaN is the gross floor area devoted to function N,
AreaT is the total gross floor area of the building.

4. The gross floor area of a building will be the sum of all floor areas, measured from the outside of exterior walls or from the center line of partitions, including basements, cellars, mezzanines, other intermediate floor tiers, and penthouses.

Table 8-2
Fuel Conversion Factors

TYPE OF FUELS	CONVERSION FACTORS (1)
ANTHRACITE COAL	28.4 MILLION BTU / SHORT TON
	7,890 Kg CAL / Kg
BITUMINOUS COAL	24.6 MILLION BTU / SHORT TON
	6,858 Kg CAL / Kg
ELECTRICITY (2)	3,413 BTU / KWH
	860.06 CAL / KWH
NO. 2 DISTILLATE FUEL OIL	138,700 BTU / GALLON
	9,271.1 Kg CAL / LITER
RESIDUAL FUEL OIL	149,700 BTU / GALLON
	10,006.4 Kg CAL / LITER
KEROSENE	135,000 BTU / GALLON
	9.023.8 Kg CAL / LITER
LP GAS	95,500 BTU / GALLON
	6,583.5 Kg CAL / LITER
NATURAL GAS	1,031 BTU / CUBIC FOOT
	44,512.4 Kg CAL / CUBIC METER
PURCHASED STEAM OR	1,000 BTU / POUND
STEAM FROM CENTRAL PLANT (3)	580.8 Kg CAL / Kg

1. At specific installations where the energy source Btu content is known to vary consistently by 10 percent or more from the values given above, the local value may be used provided there are adequate data on file for two years or more to justify the revision and that this value is expected to hold true for at least five years following building occupancy.

2. The DET values assume that no electric resistive heating will be used in the building (except auxiliary electric resistive heating used with heat pump systems). When 10 percent or more of a building's annual heating consumption will be derived from electric resistive heating, the electric resistive portion will be multiplied by 2.2 to reflect additional conversion losses.

3. High temperature, medium temperature, or chilled water from a central plant shall use the heat value of fluid based on the actual temperature and pressure delivered to the 5 ft. (1.5 m) line.

Table 8-3
Weather Region Definitions

WEATHER REGION (1)	COOLING DEG DAYS	HEATING DEGREE DAYS RANGE (BASE 65 F.)	
1 (2)	N / A	>15000	N / A
2 (2)	N / A	>13000	<=15000
3 (2)	N / A	>11000	<=13000
4 (3)	<2000	>9000	<=11000
5 (3)	<2000	>7000	<=9000
6 (3)	<2000	>5500	<=7000
7 (3)	<2000	>4000	<=5500
8 (3)	<2000	>2000	<=4000
9 (3)	<2000	N / A	<=2000
10 (4)	>2000	N / A	<=2000
11 (4)	>2000	>2000	N / A

1. The data published in NAVFAC P-89 (reference (8e)) will be used to select the appropriate weather region.

2. Weather Regions 1, 2, and 3 are determined by the Heating Degree Days Range independent of the Cooling Degree Days.

3. Weather Regions 4, 5, 6, 7, 8, and 9 are determined by the Cooling Degree Days being less than 2000 and then by the appropriate range bracket of the Heating Degree Days.

4. Weather Regions 10, and 11 are determined by the Cooling Degree Days being greater than 2000 and then by the appropriate range bracket of Heating Degree Days.

Table 8-4
Building Envelope Component Guidelines (1)
(U-factors are maximums; R-factors are minimums)

WEATHER REGION	OPAQUE WALL U (2)	GROSS WALL U (3)	BELOW GRADE R(4) (11)	GLAZING TYPE (5)	ROOF / CEILING U	EXPOSED FLOOR U (6)
1(7)	.053 / .040(8)	.125 / .091(9)	18	D / T(10)	.024	.023
2	.053	.147	16	D	.031	.040
3	.053	.147	15	D	.031	.040
4	.066	.164	13	D	.041	.040
5	.064	.181	12	D	.041	.040
6	.092	.210	10	D	.052	.049
7	.088	.212	9	D	.055	.048
8	.120	.217	8(12)	S	.066	.074
9	.230	.340	0	S	.100	.180
10	.150	.270	0	S	.057	.100
11	.150	.270	8(12)	S	.057	.100

(1) Optional Use. The values in this table are presented for optional use only, except that the values for Region 1 are mandatory. The values were derived from Federal Regulation 10 CFR 435 for a typical building in several representative climate areas. Depending on the type of building, local construction and energy costs, and micro climate, more energy efficient and / or life cycle cost effective U-factors (higher or lower) are possible. The values in this table may be used as a starting point in the building design. The final design will be dependent upon further energy and economic study, generic study results, engineering judgment, or a combination thereof. Since many buildings are not "envelope load dominate" the use of these values does not guarantee that a building's DEB will meet the appropriate DET value.

(2) Opaque wall U-factors shall be calculated in accordance with Chapter 23 of the ASHRAE, Handbook of Fundamentals (reference (8d)). The calculations shall take into account all major thermal bridges and series and parallel heat conductive paths.

(3) Gross wall U-factor is the average U-factor of all wall components opaque walls, windows, door, openings, etc.) determined by multiplying the respective U-factor times the area of each wall component then dividing the sum of the products for all wall components by the total wall area.

(4) Below grade wall R-factors are the minimum values for exterior wall assemblies (in contact with earth) of below grade conditioned spaces. Air film coefficients and thermal performance of the adjacent ground are excluded from these values.

(5) D = Double glazing with a minimum of 1/4 inch air space.
S = Single glazing with a minimum thickness of 1/8 inch.
T = Triple glazing.

(6) Exposed Floor U-factors are for floors of heated spaces over unheated areas such as open areas, garages, crawl spaces, and basements without a positive heat supply to maintain a minimum temperature of 50 degrees F (10 degrees C).

(7) ALL THE VALUES INDICATED FOR REGION 1 ARE MANDATORY. These values have been adjusted to comply with the special minimum requirements for this region in 10 CFR 435 Subpart A.

(8) Maximum U-factor of 0.040 is required for all buildings with less than 12,000 square feet floor area.

(9) Maximum U-factor of 0.091 is required for all buildings with less than 12,000 square feet floor area.

(10) Maximum U-factor for fenestration in Region 1 is .450, which will normally require double glazing with an emissivity coating or triple glazing. No skylights are permitted in Region 1.

(11) Refer to NFGS-07230 or CEGS-03300 for mandatory slab on grade perimeter insulation requirements.

(12) For locations in Regions 8 and 11 having HDD (65 degrees F) less than 3,000, the below grade wall R-factor may be 0.

Table 8-5
Facility Type Categories

Fac Type	Facility Function	Limitations
A1	Admin, Operations, Office, Police Stations	>8000 SF
A2		<8000 SF
B	Hospital Buildings	None
C	Medical Laboratories	None
D	Dental Clinics	None
E	Dispensaries	None
F	Prisons	None
G	Schools, Training and Education Centers, Classrooms, Child Care	None
H	Fire Stations	None
I	Auto Hobby Shops	None

Table 8-5 (cont)
Facility Type Categories

J	Post Offices, Chapels, Banks, Libraries, Credit Unions, Thrift Shops, Misc. Rec Buildings, Arts and Crafts Buildings	None
K	Gyms, Indoor Pool Buildings, Field Houses, Cadet Activity Centers	None
L	Clubs (NCO, Officer's, Recreation, Rod and Gun, Youth Center)	None
M	Theaters, Passenger Terminals	None
N	Dining Hall, Cafeteria, Snack Bar, Open Mess, Restaurants	None
O	Auditoriums	None
P	Museums, Memorials	None
Q	UPH, Dormitories, Transient Billeting, Cadet Housing	None
R	Storage (Medical, Munitions, Range Targets, Forms), Medical Logistics, Kennel Support, Material Process Depot	None
S	Storage (Freight, Missile, Ammunitions), Aircraft Shelter, Air Freight Terminal, Range Supplies & Equipment Storage, Indoor Small Arms Range, Parking Shed, Depot Warehouse, Hazardous Material Storage	None
T	Cold Storage	None
U1	Maintenance (Hangars, Tac Shops, Docks, Vehicle Facilities) High Bay Tech Training Areas	Clgs>10FT
U2		Clgs<10FT
V	Commissary, Base Exchange, Package Store, Service Outlet	None
W	Electronics, Labs, Control Towers, Communication Fac., Instrument Shops	None
X	Utility Plants (Boiler, Electricity Production, Sewage Treatment, Chiller)	None

REFERENCES

(8a) NIST Handbook 135, Annual Supplement, National Institute of Standards and Technology, "Energy Prices and Discount Factors for Life Cycle Cost Analysis".

(8b) Public Law 100-615, "Federal Energy Management Improvement Act of 1988", November 5, 1988.

(8c) Title 10 CFT, Subpart A, Part 435, pages 4535 - 4720 inclusive, "Energy Conservation Voluntary Performance Standards for New Commercial and Multi-Family High Rise Residential Buildings, Mandatory For Federal Buildings" (January 30, 1989)

(8d) ASHRAE Handbook of Fundamentals, American Society of Heating, Refrigerating and Air Conditioning Engineers.

(8e) Joint Services Manual, TM 5-785, NAVFAC P-89, AFM 88-29, "Engineering Weather Data," July 1978.