SUMMARY

Title III of the Energy Conservation and Production Act (the Act) (Pub. L. 94-385), as amended, requires the Secretary of Energy to promulgate an energy performance standard that is designed to achieve the maximum practicable improvements in energy efficiency in new commercial buildings and to encourage the use of nondepletable energy sources.

Since the enactment of Pub. L. 94-385 in 1976, legislative enactments have changed the focus of the act. The Department of Energy (DOE) retains the responsibility for developing performance standards for all new federal, commercial buildings; this standard serves a dual purpose. For the federal sector, the standard sets mandatory performance levels for the design of federal buildings. For the private sector, the standard is voluntary and serves as a guideline, providing technical information and examples of energy-efficient design practices. The director of each federal agency will be responsible for enacting regulations or procedures to ensure that all new federal commercial building designs meet or exceed the proposed standard. Design professionals currently engaged in designing and constructing new nonfederal commercial buildings around the country are encouraged but not mandated to use it.

Pacific Northwest Laboratory (PNL) conducted this environmental assessment to address the possible incremental environmental effects of the proposed standard on selected types of commercial buildings (see Appendix A) constructed for the federal sector. This assessment was mandated by the National Environmental Policy Act of 1969, as amended (Pub. L. 91-190, January 1, 1970), and the implementing regulations of the Council on Environmental Quality (CEQ) (40 CFR Parts 1500-1508). This environmental assessment does not examine the environmental effects of the proposed standard on private sector commercial buildings, nor does it examine the impacts on federal or private sector residential buildings other than federal sector high-rise apartments. Under the proposed standard, several areas (economic, socioeconomic and institutional) have been analyzed in a separate document (Roop and King 1985) and are only summarized in this report.

Presently, the federal government's policy is to design federal commercial buildings to comply with the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) Standard 90A-1980. ASHRAE Standard 90A-1980 has been used as the baseline from which to measure the effects of the proposed standard. The proposed standard reflects an attempt to simplify compliance, to incorporate an improved understanding of building component interactions that affect energy use, and to ensure architectural and engineering flexibility in commercial building design. The proposed standard provides significant improvements in energy efficiency over ASHRAE Standard 90A-1980. For example, the simulated energy-use analyses of office-type buildings predicted that buildings designed according to the proposed standard would use 19% less energy than if ASHRAE Standard 90A-1980 were used. Case studies of the other 7 types of buildings showed an energy savings of 10% to 15%. A more detailed description of the differences between ASHRAE Standard 90A-1980 and the proposed standard is discussed in Chapter 2.0.

In analyzing the proposed standard, PNL separated commercial type buildings into ten categories on the basis of major functional and design differences. To evaluate the effects that the proposed standard would have on energy use, capital costs, operations and maintenance (O&M) costs, and the environment, plans for existing buildings from each of the ten categories of commercial buildings were obtained. A case-study building was selected for each category. Each test building was "redesigned" on paper to meet ASHRAE Standard 90A-1980 requirements in five different climates, then upgraded again to meet the proposed standard. Each of the ten buildings was tested in a series of computer simulations. The actual buildings used in the design study and the resulting energy- and cost-savings analyses are described in a series of reports entitled Recommendations for Energy Conservation Standards and Guidelines for New Commercial Buildings, Volumes I through IV (see Appendix A) (PNL 1983). This assessment uses the simulated characteristics and performance of the ten case-study buildings to estimate the potential incremental environmental changes attributable to the proposed standard. The assessment is based on a subset of commercial building design possibilities under low, typical and worst-case conditions. The assessment brackets a wide range of potential effects in determining the incremental environmental consequences of the proposed standard.

This assessment of incremental environmental consequences emphasizes the possible alterations to building habitability (indoor air quality, health and safety) from the proposed standard. Alterations to building habitability were emphasized for two reasons. First, the impacts expected to occur in socioeconomic spheres or in the outdoor environment are very slight because of the proposed standard's similarity to ASHRAE Standard 90A-1980, its intrinsic design flexibility, and its emphasis on improved interrelationship of building components. Second, previous assessments of building standards for energy conservation have not incorporated extensive indoor environmental analyses, although this is an area of growing scientific concern.

The conclusion of this report is that the effect of the proposed design changes on building habitability, as well as on the outdoor environment, the economy and federal institutions, will be very small. Specific conclusions are summarized below.

HABITABILITY

In this assessment, habitability is expressed in terms of changes in various indoor air pollutant concentrations and concomitant occupant health and safety effects that can be related to design changes attributed to the proposed standard.

Indoor Air Quality

Various pollutants are released continuously or intermittently within commercial buildings. An indoor air quality computation model that uses specific pollution emission values (release rates) for selected materials was used to calculate pollutant concentration levels in the ten case-study buildings, based on an ASHRAE Standard 90A-1980 design for baseline conditions and on a proposed standard design. Incremental pollutant concentrations were calculated for radon, formaldehyde, particulate matter, CO and CO_2 and are shown in Table S.1.

TABLE S.1. Summary of Incremental Change in Indoor Air Quality from the Proposed Standard for Federal Commercial Buildings

Category	Radon (pCi/ℓ)		Formaldehyde (mg/m^3)		Particulate Matter W/HVAC Filter (μg/m^3)		Carbon Monoxide (mg/m^3)		Carbon Dioxide (μg/m^3)	
	Typical	Worst Case	Typical	Worst Case	Typical	Worst Case	Typical	Worst Case	Typical	Worst Case
Small Office	0	0	-0.021	-0.060	4	5	0	0	0	0
Medium Office	0	0	0	0	0	1	0	0	0	0
Large Office	0	0	0	0	6	10	0	0	0	0
Retail Store	0	0	0	0	1	1	0	0	0	0
Strip Store	0	0	0.003	0.008	5	8	0	0	0	0
Apartment	0	0	0	0	2	2	0	0	0	0
Hotel	0	0	0	0	6	10	0	0	0	0
Warehouse, Storage	0	0	-0.031	-0.088	0	0	0	0	0	0
Warehouse, Office	0	0	-0.008	-0.022	3	5	0	0	0	0
Assembly	0	0	-0.001	0.003	3	6	0	0	0	0
School Classrooms	0	0	0.002	0.007	2	2	0	0	0	0

Radon. Calculated values for indoor air concentrations of radon indicate that changes in building insulation materials; heating, ventilation and air conditioning (HVAC); lighting; and service water design do not increase the level of radon concentration for the commercial building designed to the proposed standard over the building designed to ASHRAE Standard 90A-1980.

Formaldehyde. The computed concentrations of formaldehyde depend on materials chosen for the buildings designed under the proposed standard. In the ten test buildings designed under the proposed standard, there was a tendency to replace insulating materials that emit formaldehyde with materials that emit other organic compounds (primarily because of cost and insulating performance criteria). In most of the test designs, therefore, levels of formaldehyde present in buildings designed to the proposed standard are predicted to stay the same or decline slightly in comparison to those constructed according to ASHRAE Standard 90A-1980. (Correspondingly, higher organic concentrations may occur temporarily immediately upon completion of construction in the buildings designed to the proposed standard.) Formaldehyde concentrations in new strip stores and new school classrooms may have slightly elevated formaldehyde concentrations. The increase in formaldehyde is very small. Concentrations of both formaldehyde and other organic compounds can be very age-dependent. The calculated concentrations are based on emission rates for new insulation materials. Aging will considerably reduce the actual long-term average concentration expected to occur in commercial buildings designed under either ASHRAE Standard 90A-1980 or the proposed standard.

Combustion Products. The estimated concentration of total suspended particulates (TSP) may increase slightly between the buildings designed under ASHRAE Standard 90A-1980 and the proposed standard because HVAC modifications in the latter tend to reduce the rate that air is passed through filters. (The volume of fresh air used to ventilate the building remains constant, however.) The incremental increase in TSP levels is small even under worst-case assumptions. However, in the test-design analysis, the total TSP for several building types (the retail store, the strip store, the hotel, and assembly building) are calculated under worst-case conditions to be over a value of 75 micrograms per meter cubed ($\mu g/m^3$) for both the ASHRAE Standard 90A-1980 design and the proposed standard design. No specific indoor air quality standard for TSP has been set, although the primary standard for outdoor air set by the National Ambient Air Quality Standard is 75 μ/m^3. The 75 μ/m^3 exceedence suggests that TSP sources such as tobacco smoking may need to be further controlled under worst-case conditions, and/or ventilation rates need to be increased to reduce TSP concentrations. CO and CO_2 concentrations were estimated to remain unchanged when substituting the proposed standard design for the ASHRAE Standard 90A-1980 design.

Effects on Health and Safety

In most of the test-building simulations, estimated pollutant concentrations did not change as a result of the proposed standard design. Where small increases in pollutant concentrations did occur, the health effect of these small changes is expected to be negligible. Although our current knowledge about health effects associated with common indoor air pollutants is limited, the small changes that appear possible with the use of the proposed standard design are unlikely to increase the risk of adverse health effects.

The proposed standard does not result in new or radical design approaches but rather in a fine-tuning of existing design approaches to reduce whole building energy consumption. Thus, the proposed standard is not in conflict with relevant health and safety standards. For example, the ASHRAE standard for ventilation (ASHRAE Standard 62-1981), which sets required amounts of outside air for acceptable indoor air quality, was applied to buildings designed under both the ASHRAE Standard 90A-1980 and the proposed standard. All other existing standards for building occupant's health and safety were also applied in both cases. Changes made to lighting, heating, ventilation, air conditioning, service hot water, and envelope design are expected to have very small incremental impacts on human health and safety.

EFFECTS ON OUTDOOR ENVIRONMENT

Improving the thermal resistance of a building's envelope will often require additional use of insulation and glass. More energy-efficient buildings will reduce the oil, natural gas, or electricity requirements for lighting, heating, and cooling. Any reduction in energy use will, in turn, decrease the volume of pollutants that are released into the environment because less energy will be developed and transported to heat/cool and light the building.

Any increase in the production of insulation and glass to improve the building envelope is assumed to have minimal environmental consequences. Ambient land, air, and water quality standards and the industry's ability to comply with those standards should not be substantially affected by the increased production because any additional emissions would be an extremely small part of current emissions to the environment. While it was not possible to calculate the net effect on the outdoor environment in this assessment, the effect most likely will be positive because reductions in pollutant emissions to the environment due to decreases in energy consumption will occur over the life of the building.

ECONOMIC EFFECTS

The total net benefit (reduction in cost of ownership and operation) of fully implementing the proposed standard for the federal sector is $165.6 million (1982 dollars). These energy expenditure savings represent about 3.6% of the expected cost of owning and operating the buildings constructed under the proposed standard during the 1981-2000 period. The reduction in energy expenditures alone is $141.9 million (a 17.9% reduction) and is composed of an electricity cost reduction of $140.6 million and a natural gas cost reduction of $1.3 million. O&M costs would decline by $20.3 million (2.0%) and capital expenses would decline by $3.4 million (0.1%). Capital costs would decline primarily from down-sizing heating and air conditioning equipment when the energy efficiency of the building is increased.

The indirect changes that occur as a result of imposing the standard on federal building construction would be modest. Total output for all industries would be reduced by about $140 million, almost the same magnitude of change as the net benefits. This decline in output occurs mainly in capital-intensive industries (primarily utilities) with some offsetting increase in output in more labor-intensive industries. Therefore, employment actually would increase by about 1,500 man-year of employment over the 20-year period, or an average of about 75 man-years of employment per year.

EFFECTS ON INSTITUTIONS

The proposed standard is not radically different from standards already being used by the federal government or recommended to private sector designers by ASHRAE. In developing the proposed standard, the DOE updated and improved ASHRAE Standard 90A-1980 to minimize the impacts of implementation on both federal agencies and private sector commercial building designers who might voluntarily use the proposed standard. Although not mandatory, use of ASHRAE Standard 90A-1980 is already an accepted and established practice within federal and private design communities. Therefore, federal agencies most likely will not experience any disruption to the procedures, calculations, and design practices that they already use when designing new commercial buildings.