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ENVIRONMENTAL ASSESSMENT FOR PROPOSED ENERGY CONSERVATION STANDARDS FOR REFRIGERATORS, REFRIGERATOR-FREEZERS, AND FREEZERS

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ENVIRONMENTAL ASSESSMENT FOR THE PROPOSED ENERGY CONSERVATION STANDARD FOR REFRIGERATORS, REFRIGERATOR-FREEZERS, AND FREEZERS

1. INTRODUCTION AND NEED FOR PROPOSED ACTION

This Environmental Assessment (EA) on the candidate energy conservation standards for refrigerators, refrigerator-freezers, and freezers was prepared pursuant to the National Environmental Policy Act of 1969 (NEPA), regulations of the Council on Environmental Quality, Title 40, Code of Federal Regulations, Parts 1500 through 1508. The proposed energy conservation standard (Level 1) and the alternative standards are being reviewed in an energy-efficiency standards rulemaking that the Department has undertaken pursuant to the Energy Policy and Conservation Act, as amended by the National Energy Conservation Policy Act and the National Appliance Energy Conservation Act [1]. See Notice of Proposed Rulemaking Regarding Energy Conservation Standards for Refrigerators, Refrigerator-Freezers, and Freezers. 60 FR 37388 (July 20, 1995). A draft EA was prepared and made available to the public at the time of publication of the proposed rule. The Department received no comments on the draft EA.

The EA presents the associated environmental impacts from four energy conservation standards for this type of household appliance. For purposes of this EA, each standard is an alternative action and is compared to what is expected to happen if no new standards for this type of product were finalized, i.e., the "no action" alternative. Of the four energy conservation standard levels considered, standard level 4 has the highest level of energy efficiency and the largest environmental impact. The proposed action implementing Standard Level 1 would have the least environmental impacts, through emission reductions, of the four alternatives.

The description of the standards below results from the appliance energy-efficiency analyses conducted for the rulemaking. The presentation of environmental impacts for each of the alternatives appears at Section 3 of the EA.

The proposed Standard Level 1. This standard level is projected to save 7.0 quadrillion British thermal units (quads), the equivalent of 6.7 exajoules (EJ) of energy for refrigerators and refrigerator-freezers, and 0.5 quads (0.4 EJ) for freezers. The technologies that are necessary to meet this standard level are presently available. The consumer payback (i.e. repayment of purchase price increase) of this standard level is 3.7 years for the largest class and no more than 9.2 years for any class.

This standard is at or near the lowest life-cycle cost for all classes and is expected to result in a reduction in life-cycle cost of approximately $143 or 11.5 percent for the largest class. The standard is expected to have essentially no impact on the prototypical manufacturer's return on equity of 7.3 percent.

Standard Level 2. This standard level is projected to save 7.8 quads (8.2 EJ) of energy for refrigerators and refrigerator-freezers, and 1.3 quads (1.4 EJ) for freezers. However, this level requires an increase in insulation with a corresponding increase in wall thickness. Furthermore, the payback may be as long as 19.0 years, the expected life of the product. The Notice of Proposed Rulemaking that the initial burden on the manufacturers would be unacceptably high for their standard level: short-run return on equity for both refrigerators and freezers decreases from 7.3 percent to 6.2 percent, a reduction of 16 percent.

Standard Level 3. This standard level is projected to save 8.6 quads (9.1 EJ) of energy for refrigerators and refrigerator-freezers and 1.7 quads (1.8 EJ) for freezers. While this level does not use vacuum panels, for most of the classes about 40 percent of the energy savings are obtained by increasing the insulation values. The Notice of Proposed Rulemaking noted that there is general agreement that an increase in the wall thickness is not acceptable for many of the larger models in each class. This level has payback periods as high as 25.5 years (much longer than the product life) and reduces refrigerator manufacturer short-run return on equity from 7.3 percent to 5.8 percent, a reduction of 20 percent. For freezer manufacturers, short-run return on equity drops from 7.3 percent to 4.7 percent, a reduction of more than 35 percent.

Standard Level 4. Standard level 4, the maximum technologically feasible (Max Tech) level of efficiency, would save the most energy: 10.0 quads (10.55 EJ) for refrigerators (including refrigerator-freezers) and 2.0 quads (2.11 EJ) for freezers between 1998 and 2030. In order to meet this standard, the Department assumes that all refrigerator products would incorporate vacuum panel insulation. The use of vacuum panel insulation accounts for 30 percent of total energy savings, with increased wall thickness as the only alternative. The Notice of Proposed Rulemaking that reported that vacuum panel technology has progressed, but it is not ready to be applied as a reliable design option in the production of a 1998 compliant product. There are concerns about manufacturability, availability, reliability, and performance. Vacuum panels are 6 to 10 times heavier than foam. The increase in door weight may cause the appliance to tip over when the door is opened. Also, current production capability for vacuum panels is far too small for the projected demand. A 1-inch increase in wall and door thickness (a 2-inch increase in the side-to-side dimension) is not a viable option. Many products are already constrained by the need to fit into existing spaces and through doors and passage-ways. Decreasing interior volume would sacrifice product utility.

In the evaluation of the proposed action and the alternatives, the primary environmental concern that is addressed is atmospheric emissions from fossil-fueled electricity generation. Residential refrigeration is fueled almost entirely by electricity, and this standard is not expected to affect propane residential refrigeration, which is widely used only where grid power is unavailable. The proposed design options for this appliance type would result in decreased electricity use and, therefore, a reduction of power plant emissions. The greatest decreases in air pollution would be for sulfur oxides, listed in equivalent weight of sulfur dioxide, or SO_2. Reductions of nitrogen oxides and carbon dioxide would also occur and are listed by weight of NO_2 and CO_2, respectively. CO_2 emissions from fossil-fuel burning is considered an environmental hazard because it contributes to the "greenhouse effect" by trapping heat energy from the earth that is emitted as infrared radiation. The greenhouse effect is expected gradually to raise the mean global temperature.

Although the quantity of raw materials used per appliance would remain relatively constant, in most scenarios increased initial cost is expected to decrease slightly the number of appliances sold, resulting in small decreases in raw materials used. The main effect of the appliance production decrease would be reduced SO_2 emitted in steel production. That reduction would be small, however, in comparison to the SO_2 decreases from fuel burning avoided at power plants. The contribution from steel production is not included in the estimates for net SO_2 decreases resulting from design changes in these products.

The effects on particulate emissions related to the proposed standard-induced decrease in electricity generation would be minor compared to effects on decreases in SO_2, NO_x, and CO_2. For example, in 1984, power plants contributed only 7% of U.S. total particulate emissions as compared to contributions of 83% and 34% to total SO_2 and NO_x emissions, respectively. Though the reduction in particulate emissions would be relatively small, any reduction would possibly be beneficial to improving the quality of surface water. Since the amount of particulates emitted would be decreased, it is very likely that less particulates would reach surface water.

Reductions in particulate emissions accompanied by decreases in SO_2 and NO_x would have other beneficial effects on the environment. The resultant improvement to air quality and the decreased potential of acid rain formation would help improve the quality of wetlands and fish and wildlife as well as aid in the preservation of historical and archaeological sites. Reductions in NO_x emissions within warm urban areas is particularly beneficial because it is an urban smog precursor gas as well as an air pollutant in its own right.

2. METHODS OF ESTIMATING ENVIRONMENTAL IMPACTS

The greatest impacts of the proposed action and alternative standards would be a reduction in electricity demand growth. The main environmental effects of power plants on air and water quality result from emissions of sulfur dioxide (SO_2), nitrogen oxides (NO_x), and carbon dioxide (CO_2). Since the proposed standards would lessen the need for electricity generation, power plant emissions would be reduced.

2.1 Baseline Emissions

In the Service Report that accompanies the 1991 National Energy Strategy (NES) [2], the impact on power plant emissions as a result of Title IV of the Clean Air Act Amendments of 1990, P. L. 101-549, 104 Stat. 2399 (Nov. 15, 1990) codified as amended at 42 U. S. C. § § 7401-7626 (Supp. II 1990) are estimated. These estimates comprise the baseline case, and serve as the basis for comparison of emission reductions among the proposed standard and alternatives.

In the report accompanying the 1991 NES, two possible outcomes are presented, a flexible case and a restricted case, so that the effect of different levels of permitted trading of emission allowances can be evaluated. (The report does not go beyond this explanation in defining the differences between the two cases.) As presented in the report, the results for the two cases are virtually identical. Because the two cases are so similar, only the U.S. power plant emission projections for the three effluents under the assumptions made in the flexible case are presented. Tables 1.a and 1.b summarize the results.

Table 1.a Projected U.S. CO_2, SO_2, and NO_x Power Plant Emissions - Baseline Case (Metric Units)

Year	CO_2 Million tons (Mt)	SO_2 Million tons (Mt)	NO_x Million tons (Mt)
1995	2025	12.5	7.6
2000	2274	8.2	6.1
2010	2920	7.6	6.6
2020	3596	6.1	6.1
2030	4358	4.4	5.4

Table 1.b Projected U.S. CO_2, SO_2, and NO_x Power Plant Emissions - Baseline Case (Inch-Pound Units)

Year	CO_2 *10^6* short tons	SO_2 *10^6* short tons	NO_x *10^6* short tons
1995	2233	13.8	8.4
2000	2506	9.0	6.7
2010	3219	8.4	7.3
2020	3964	6.7	6.7
2030	4804	4.8	5.9

2.1(a) Sulfur and Nitrogen Oxide Emissions

For each of the alternatives analyzed, emissions abated from fossil fuel-burning power plants are estimated. In the analysis of the impacts of design changes to the appliances, lower sulfur emissions resulting from decreased steel production are not considered. No changes in the amount of steel used per unit are expected.

In order to reflect more fully the effects of cleaner-burning power plants in future years, emission rates (g/kWh) for power plant fuel-burning are calculated from projected emissions and electrical generation data. The electrical generation data is translated below into energy use (EJ) by assuming a 30% overall energy conversion efficiency. As noted above, the source of these projected emissions and electrical generation data is the Service Report that accompanied the 1991 NES (data for Tables 1.a and 1.b were extracted from the same Service Report). Tables 2.a and 2.b present these data and the calculated emission rates for SO_2 and NO_x.

Table 2.a Projected Electricity Generation, Emissions Data, and Emission Rates for SO_2 and NO_x at Fossil Fuel-Burning Power Plants - Metric Units

Year	Electricity Generation (TeraWattHours) (TWH)			Energy Use	Emissions (Million Tons) (MT)		Emissions Rates(generation) gram/kiloWatthours (g/kWh)	
	Coal	Oil	Gas	Total Exajoules	SO_2	NO_x	SO_2	NO_x
1995	1602.2	193.7	442.0	27	12.5	7.6	5.6	3.4
2000	1814.0	179.8	605.0	31	8.2	6.1	3.1	2.3
2010	2660.6	149.9	482.5	40	7.6	6.6	2.3	2.0
2020	3727.8	67.2	292.3	49	6.1	6.1	1.5	1.5
2030	4837.3	29.0	179.2	61	4.4	5.4	0.9	1.1

Table 2.b Projected Electricity Generation, Emissions Data, and Emission Rates for SO_2 and NO_x at Fossil Fuel-Burning Power Plants - Inch-Pound Units

Year	Electricity Generation (kiloWatthours) (kWh)			Energy Use	Emissions		Emissions Rates (primary)	
	Coal 10^9	Oil 10^9	Gas 10^9	Total quadrillion British tons (Quads)	SO_2 10^6 short tons	NO_x 10^6 short tons	SO_2 10^3 tons/Quad	NO_x 10^3 tons/Quad
1995	1602.2	193.7	442.0	25.74	13.8	8.4	552.5	336.3
2000	1814.0	179.8	605.0	29.89	9.0	6.7	310.3	231.0
2010	2660.6	149.9	482.5	37.88	8.4	7.3	228.6	198.6
2020	3727.8	67.2	292.3	47.01	6.7	6.7	146.9	146.9
2030	4837.3	29.0	179.2	58.03	4.8	5.9	85.2	104.8

The calculated emissions rate data listed in Tables 2.a and 2.b represent the average SO_2 and NO_x emissions rates for all fossil fuel-burning power plants in the United States. Emissions rates were not calculated for each fuel-burning source as the emissions data supplied by the Service Report were not disaggregated according to power plant type (i.e., coal, oil, gas). To obtain emission rate values, the amount of emissions was divided by the total energy use of fossil fuel-burning power plants. The total energy use by fossil fuel-burning power plants was calculated from the electrical generation data supplied by the report accompanying the 1991 NES. The electrical generation data was disaggregated by fuel source. To obtain the total energy use (input), the electrical generation data from each fossil fuel source was summed and then divided by the assumed efficiency of fossil fuel-burning power plants (30%), which includes transmission and distribution losses. This fossil fuel-burning power plant efficiency is consistent with that used by the LBL Residential Energy Model (LBL-REM).

The amount of SO_2 and NO_x emissions abated for any particular year is determined by multiplying the estimates of energy saved through reduced electricity generation in that year by the emission rate for that particular year. For years not covered in the Service Report, linear interpolation was used to derive emission rates and, in turn, the corresponding abated emissions.

2.1(b) Carbon Dioxide Emissions

Emission rates for CO_2 were derived in the same manner as those derived for SO_2 and NO_x. Table 3.a and 3.b present the CO_2 emission rate data as derived from the electrical generation data and emissions data supplied by the 1991 NES Service Report.

Table 3.a Projected Electricity Generation Data, Emissions Data, and Emissions Rates for CO_2 at Fossil Fuel-Burning Power Plants - Metric Units

	Electricity Generation					
Year	Coal TeraWattHours (TWH)	Oil TeraWattHours (TWH)	Gas TeraWatt Hours (TWH)	Energy Use Total Exajoules (EJ)	Emission CO_2 Million Tons (MT)	Emission Rate CO_2 grams/kiloWatthours (g/kWh)
1995	1602.2	193.7	442.0	27	2025	905
2000	1814.0	179.8	605.0	31	2274	875
2010	2660.6	149.9	482.5	40	2920	887
2020	3727.8	67.2	292.3	49	3596	880
2030	4837.3	29.0	179.2	61	4358	864

Table 3.b Projected Electricity Generation Data, Emissions Data, and Emissions Rates for CO_2 at Fossil Fuel-Burning Power Plants - Inch-Pound Units

Year	Electricity Generation			Energy Use Total quadrillion British tons (Quads)	Emission CO_2 10^6 short tons	Emission Rate CO_2 10^6 tons/Quad
	Coal 10^9 kiloWatt hours (KWh)	Oil 10^9 kiloWatt hours (KWh)	Gas 10^9 kiloWatt hours (KWh)			
1995	1602.2	193.7	442.0	25.74	2232.5	89.39
2000	1814.0	179.8	605.0	29.89	2506.2	86.41
2010	2660.6	149.9	482.5	37.88	3219.3	87.60
2020	3727.8	67.2	292.3	47.01	3964.2	86.90
2030	4837.3	29.0	179.2	58.03	4804.4	85.32

As with the SO_2 and NO_x emissions, the amount of CO_2 emissions abated for any particular year is determined by multiplying the estimates of energy saved through reduced electricity generation by the emission rate for that particular year. For years not covered in the Service Report, linear interpolation was used to derive emission rates and, in turn, the corresponding abated emissions.

3. ENVIRONMENTAL IMPACTS

The following results in Table 4-7 indicate projected changes that could be brought about in the amounts of emitted CO_2, SO_2, and NO_x by imposing efficiency standards for appliances at each of the four standard levels considered in this analysis. A table is presented for each of the standard levels. Each table details the changes that would occur to each of the three emissions (i.e., CO_2, SO_2, and NO_x) through the implementation of a particular standard level for this type of appliance. Each table shows, for a specific year between 1998, the first year in which the proposed standard would be implemented, and 2030, the amount of emission abated from power plant generation, as compared against the baseline case. Also included are the cumulative changes of each pollutant (between the years 1998 and 2030). The estimated of SO_2, NO_x, and CO_2 in Tables 4-7 are also exposed as a percentage of U.S. power plant emissions for the year under consideration.

3.1 Sulfur and Nitrogen Oxide Emissions

Sulfur dioxide emissions would be decreased by a cumulative total of up to 1720 kt (1896 thousand short tons) between 1998 and 2030 at energy conservation standard level 4, the most stringent standard level. In the year 2000, Standard Level 4 decreases in SO_2 would represent about 0.19% of the SO_2 emissions estimated to come from power plants in that year. In the year 2030, decreases in SO_2 emissions will represent about 1.2% of the SO_2 emissions estimated to come from power plants in that year. As discussed earlier, the possible reductions of SO_2 emissions caused by standards will reduce the utility's need to purchase allowances or permit it to save them for future use, or sell them. To the extent saved allowances are used for future emissions, the standards' net effect on those SO_2 emissions would be only a reduction in the demand for emissions allowances.

Standard Level 4 design changes to residential refrigeration would result in an estimated decrease in NO_x emissions of 1635 kt (1802 thousand short tons) between 1998 and 2030. NO_x decreases would represent 0.19% and 1.2% of the NO_x emissions estimated to come from power plants in the years 2000 and 2030, respectively.

3.2 Carbon Dioxide Emissions

The cumulative reduction in CO_2 emissions from Standard Level 4 design changes is 914 Mt (1007 million short tons of CO_2).

Table 4. Projected Reduction of Pollutants for Refrigerators, Refrigerator-Freezers, and Freezers, Standard Level One

SO_2

Year	Abated from Power Plant Generation		Total Emissions		% U.S. SO_2 Power Plant Emissions
	kt	(10^3 of short tons)	kt	(10^3 of short tons)	
1998	4.9	5.4	12362	13623	-0.04
2000	11.2	12.3	9853	10858	-0.11
2005	26.8	29.5	8867	9772	-0.30
2010	38.8	42.8	7956	8767	-0.49
2015	42.3	46.6	6546	7214	-0.65
2020	38.5	42.5	5489	6048	-0.70
2025	31.1	34.3	4412	4862	-0.70
2030	24.5	27.0	3488	3844	-0.70

Cumulative SO_2 reduction, 1998-2030 = 1017 kt (1120 thousand short tons)

NOx

Year	Abated from Power Plant Generation		Total Emissions		% U.S. NO_x Power Plant Emissions
	kt	(10^3 of short tons)	kt	(10^3 of short tons)	
1998	3.3	3.7	8356	9208	-0.04
2000	8.3	9.2	7335	8083	-0.11
2005	21.6	23.8	7136	7864	-0.30
2010	33.7	37.2	6914	7619	-0.49
2015	39.2	43.2	6070	6689	-0.65
2020	38.5	42.5	5489	6048	-0.70
2025	34.1	37.6	4836	5330	-0.70
2030	30.2	33.3	4289	4726	-0.70

Cumulative NO_x reduction, 1998-2030 = 966 kt (1065 thousand short tons)

CO_2

Year	Abated from Power Plant Generation		Total Emissions		% U.S. CO_2 Power Plant Emissions
	Mt	(10^9 short tons)	kt	(10^6 short tons)	
1998	1.1	1.2	2714	2990	-0.04
2000	3.1	3.4	2744	3024	-0.11
2005	8.8	9.7	2918	3216	-0.30
2010	14.9	16.4	3049	3360	-0.49
2015	20.1	22.2	3114	3432	-0.65
2020	22.8	25.1	3248	3579	-0.70
2025	23.7	26.1	3365	3708	-0.70
2030	24.6	27.1	3491	3848	-0.70

Cumulative CO_2 reduction, 1998-2030 = 540 Mt (595 million short tons)

Table 5. Projected Reduction of Pollutants for Refrigerators, Refrigerator-Freezers, and Freezers, Standard Level Two

SO_2

Year	Abated from Power Plant Generation kt	(10³ of short tons)	Total Emissions kt	(10³ of short tons)	% U.S. SO_2 Power Plant Emissions
1998	6.0	6.6	12362	13623	-0.05
2000	14.5	16.0	9853	10858	-0.15
2005	34.0	37.5	8867	9772	-0.38
2010	49.3	54.3	7956	8767	-0.62
2015	53.7	59.2	6546	7214	-0.82
2020	49.0	54.0	5489	6048	-0.89
2025	39.5	43.6	4412	4862	-0.90
2030	31.2	34.3	3488	3844	-0.89

Cumulative SO_2 reduction, 1998-2030 = 1292 kt (1424 thousand short tons)

NO_x

Year	Abated from Power Plant Generation kt	(10³ of short tons)	Total Emissions kt	(10³ of short tons)	% U.S. NO_x Power Plant Emissions
1998	4.0	4.4	8356	9208	-0.05
2000	10.8	11.9	7335	8083	-0.15
2005	27.4	30.2	7136	7864	-0.38
2010	42.8	47.2	6914	7619	-0.62
2015	49.8	54.9	6070	6689	-0.82
2020	49.0	54.0	5489	6048	-0.89
2025	43.3	47.8	4836	5330	-0.90
2030	38.4	42.3	4289	4726	-0.89

Cumulative NO_x reduction, 1998-2030 = 1228 kt (1353 thousand short tons)

CO_2

Year	Abated from Power Plant Generation Mt	(10⁹ short tons)	Total Emissions kt	(10³ of short tons)	% U.S. CO_2 Power Plant Emissions
1998	1.3	1.40	2714	2990	-0.05
2000	4.0	4.40	2744	3024	-0.15
2005	11.2	12.30	2918	3216	-0.38
2010	18.9	20.80	3049	3360	-0.62
2015	25.6	28.20	3114	3432	-0.82
2020	29.0	32.00	3248	3579	-0.89
2025	39.5	43.60	4412	4862	-0.90
2030	31.2	34.30	3488	3844	-0.89

Cumulative CO_2 reduction, 1998-2030 = 686 Mt (756 million short tons)

Table 6. Projected Reduction of Pollutants for Refrigerators, Refrigerator-Freezers, and Freezers, Standard Level Three

SO_2

Year	Abated from Power Plant Generation kt	Abated from Power Plant Generation (10³ of short tons)	Total Emissions kt	Total Emissions (10³ of short tons)	% U.S. SO_2 Power Plant Emissions
1998	7.0	7.7	12362	13623	-0.06
2000	16.4	18.1	9853	10858	-0.17
2005	38.7	42.6	8867	9772	-0.44
2010	55.9	61.7	7956	8767	-0.70
2015	60.8	67.1	6546	7214	-0.93
2020	55.6	61.3	5489	6048	-1.01
2025	44.9	49.5	4412	4862	-1.02
2030	35.5	39.1	3488	3844	-1.02

Cumulative SO_2 reduction, 1998-2030 = 1465 kt (1615 thousand short ton)

NO_x

Year	Abated from Power Plant Generation kt	Abated from Power Plant Generation (10³ of short tons)	Total Emissions kt	Total Emissions (10³ of short tons)	% U.S. NO_x Power Plant Emissions
1998	4.7	5.2	8356	9208	-0.06
2000	12.2	13.5	7355	8083	-0.17
2005	31.1	34.3	7136	7864	-0.44
2010	48.6	53.6	6914	7619	-0.70
2015	56.4	62.2	6070	6689	-0.93
2020	55.6	61.3	5489	6048	-1.01
2025	49.2	54.2	4836	5330	-1.02
2030	43.6	48.1	4289	4726	-1.02

Cumulative NO_x reduction, 1998-2030 = 1393 kt (1535 thousand short tons)

CO_2

Year	Abated from Power Plant Generation Mt	Abated from Power Plant Generation (10⁶ of short tons)	Total Emissions kt	Total Emissions (10³ of short tons)	% U.S. CO_2 Power Plant Emissions
1998	1.5	1.7	2714	2990	-0.06
2000	4.6	5.0	2744	3024	-0.17
2005	12.7	14.0	2918	3216	-0.44
2010	21.4	23.6	3049	3360	-0.70
2015	28.9	31.9	3114	3432	-0.93
2020	32.9	36.3	3248	3579	-1.01
2025	34.2	37.7	3365	3708	-1.02
2030	35.5	39.2	3491	3848	-1.02

Cumulative CO_2 reduction, 1998-2030 = 778 Mt (858 million short tons)

Table 7. Projected Reduction of Pollutants for Refrigerators, Refrigerator-Freezers, and Freezers, Standard Level Four

SO_2

Year	Abated from Power Plant Generation		Total Emissions		% U.S. SO_2 Power Plant Emissions
	kt	(10^3 of short tons)	kt	(10^3 of short tons)	
1998	8.1	8.9	12362	13623	-0.07
2000	19.1	21.1	9853	10858	-0.19
2005	45.4	50.1	8867	9772	-0.51
2010	65.6	72.3	7956	8767	-0.82
2015	71.5	78.8	6546	7214	-1.09
2020	65.3	72.0	5489	6048	-1.19
2025	52.7	58.1	4412	4862	-1.20
2030	41.6	45.9	3488	3844	-1.19

Cumulative SO_2 reduction, 1998-2030 = 1720 kt (1896 thousand short tons)

NO_x

Year	Abated from Power Plant Generation		Total Emissions		% U.S. NO_x Power Plant Emissions
	kt	(10^3 of short tons)	kt	(10^3 of short tons)	
1998	5.5	6.0	8356	9208	-0.07
2000	14.2	15.7	7335	8083	-0.19
2005	36.6	40.3	7136	7864	-0.51
2010	57.0	62.8	6914	7619	-0.82
2015	66.3	73.1	6070	6689	-1.09
2020	65.3	72.0	5489	6048	-1.19
2025	57.8	63.7	4836	5330	-1.20
2030	51.2	56.4	4289	4726	-1.19

Cumulative NO_x reduction, 1998-2030 = 1635 kt (1802 thousand short tons)

CO_2

Year	Abated from Power Plant Generation		Total Emissions		% U.S. CO_2 Power Plant Emissions
	kt	(10^3 of short tons)	kt	(10^3 of short tons)	
1998	1.8	2.0	2714	2990	-0.07
2000	5.3	5.9	2744	3024	-0.19
2005	14.9	16.5	2918	3216	-0.51
2010	25.1	27.7	3049	3360	-0.82
2015	34.0	37.5	3114	3432	-1.09
2020	38.6	42.6	3248	3579	-1.19
2025	40.2	44.3	3365	3708	-1.20
2030	41.7	46.0	3491	3848	-1.19

Cumulative CO_2 reduction, 1998-2030 = 914 Mt (1007 million short tons)

3.3 Cumulative Impacts

The CAAA calls for SO_2 emissions reductions in two phases. In the first phase of the planned reductions (beginning December 31, 1995 and carrying through the year 2000), electric utilities will have several options for reducing their SO_2 emissions to comply with the allowance constraints imposed by the CAAA. The major options are 1) to decrease use of high emission units and increase the use of their clean units, 2) to switch units using high sulfur coal to low sulfur coal, 3) to retrofit plants emitting at a high rate with emissions-reduction technologies (e.g., scrubbers), 4) to purchase allowances from other utilities that reduce their emissions below their permitted levels, and 5) to purchase power rather than generate it. Most utilities will make use of a combination of these options to minimize the cost of complying with the allowance constraints. Total SO_2 emissions by utilities cannot exceed 8.1 Mt (8.9 million short tons) after December 31, 2000.

In the second phase of the planned reductions (beginning December 31, 2000), the options available to electric utilities for maintaining the 8.1 Mt cap will broaden with the expected introduction of new, advanced generating technologies. However, during this period utilities will be less able to reduce emissions by changing the way they utilize their plants. Since most plants will be fully utilized, there will be few opportunities for reducing emissions by decreasing the use of a high emission plant or for further fuel switching.

The proposed adoption of the efficiency standard level 1 for this type of appliance would likely not affect the overall quantity of physical emissions of SO_2 which, because of SO_2 allowance trading, will hover near the ceiling permitted under the CAAA. This is not to say that there would be no SO_2 emissions benefit to be derived from the lowered electricity demand expected from the proposed appliance standard. Actual physical emissions would not necessarily be lowered, but the demand for SO_2 allowances by electricity generators would be reduced, resulting in lower allowance prices, and lower electric utility compliance costs. In other words, lowered generation is a costless means for a utility to achieve some of the SO_2 reduction required by the CAAA. Estimating these effects as they reverberate through SO_2 allowance trading, however, is beyond the scope of this analysis. Therefore, emissions reductions by weight are simply estimated and reported, as if the allowance trading market did not exist.

3.4 Environmental Justice

Because neither the proposed adoption of Standard Level 1 nor the alternative standards would have adverse impacts on the environment, there would be no disproportionate and adverse impacts on low-income and minority communities pursuant to Executive Order 12898 on Environmental Justice.

3.5 List of Agencies and Persons Consulted

None.

REFERENCES

1. National Appliance Energy Conservation Act (NAECA), Public Law 100-12, March 17, 1987.

2. U.S. DOE. Energy Information Administration. *Effects of the Clean Air Act Amendments on Reducing SO_2/NO_x Emissions*. Energy Information Administration, SR/NES/90-01, 1990.

POLLUTANT REDUCTIONS FOR REFRIGERATORS, REFRIGERATOR-FREEZERS AND FREEZERS

Standard Level: Final Rule
AEO97 Fuel Prices

SO_2 emissions:

Year	Abated from Power Plant kt	Abated from Power Plant 000's short tons	Abated from In House kt	Abated from In House 000's short tons	Total Reduction in Emissions kt	Total Reduction in Emissions 000's short tons	Reduction as a % of Total Residential Emissions
2005	21.96	24.20	-0.13	-0.15	21.82	24.05	0.56
2010	43.79	48.26	-0.54	-0.59	43.25	47.66	1.16
2015	62.06	68.39	-0.81	-0.89	61.25	67.50	1.70
2020	71.66	78.96	-0.94	-1.04	70.71	77.93	2.06
2025	73.35	80.84	-0.94	-1.04	72.41	79.80	2.16
2030	68.00	74.93	-1.08	-1.19	66.92	73.75	2.15

Cumulative SO_2 reduction, 1545 kt = 1703 000 short tons

NOx emissions:

Year	Abated from Power Plant kt	Abated from Power Plant 000's short tons	Abated from In House kt	Abated from In House 000's short tons	Total Reduction in Emissions kt	Total Reduction in Emissions 000's short tons	Reduction as a % of Total Residential Emissions
2005	18.91	20.84	-0.37	-0.41	18.54	20.43	0.52
2010	39.81	43.87	-0.90	-0.99	38.91	42.88	1.08
2015	57.92	63.83	-1.42	-1.56	56.51	62.27	1.58
2020	66.35	73.12	-1.79	-1.97	64.56	71.14	1.90
2025	61.62	67.90	-2.01	-2.22	59.60	65.68	1.94
2030	55.63	61.31	-2.16	-2.38	53.47	58.93	1.90

Cumulative NOx reduction, 1362 kt = 1501 000 short tons

CO_2 emissions:

Year	Abated from Power Plant Mt	Abated from Power Plant Million short tons	Abated from In House Mt	Abated from In House Million short tons	Total Reduction in Emissions Mt	Total Reduction in Emissions Million short tons	Reduction as a % of Total Residential Emissions
2005	5.55	6.11	-0.40	-0.44	5.14	5.67	0.39
2010	11.92	13.13	-1.00	-1.10	10.92	12.03	0.80
2015	18.48	20.37	-1.57	-1.73	16.91	18.63	1.19
2020	23.46	25.85	-1.97	-2.17	21.49	23.68	1.44
2025	25.79	28.42	-2.21	-2.44	23.58	25.99	1.51
2030	27.01	29.77	-2.38	-2.62	24.64	27.15	1.52

Cumulative CO_2 reduction, 465 Mt = 513 000 000 short tons