linked, that a new operating definition of max tech should be developed, and that the process should consider patent restrictions, toxicity, functional viability, verifiability, and reliability. (Maytag, Transcript at 317–19).

The Department believes that the max tech level should reflect a product that is capable of being assembled, but not necessarily mass produced, by the effective date of the amended standards. (This issue is discussed in more detail in the section on Maximum Technologically Feasible Levels, II.A.2.)

B. *Product-Specific Comments*

1. Classes.

a. Compacts. The current energy efficiency standards specify standards for seven classes of refrigerators and refrigerator-freezers and three classes of freezers. The classes are based on various characteristics of the products such as type of defrost, location of the freezer and whether the unit has through-the-door features. No consideration was given to dividing the refrigerator products in different classes based on size. The Joint Comments proposed establishing separate classes for compact refrigerator products which would include all products less than 7.75 cubic feet (Federal Trade Commission (FTC)/AHAM rated volume) and 36 inches or less in height. The marketplace and industry recognize products meeting these criteria as a separate niche with special engineering and investment constraints. Much smaller, privately-held, family-owned, single-product companies are typical in this market. Economies of scale for these companies are much different from those of the full-size product manufacturers. Also, there are far fewer design options available to improve the performance of the compact refrigerator products. (Joint Comments, No. 49 at 15).

The Department has decided to adopt additional classes for compact refrigerator products because they have added consumer utility (ability to fit in small spaces), and because there are fewer energy conservation design options available for compacts. The additional compact classes are Nos. 11–18 in the ''Product Classes and Effective Dates'' Table found at the end of this NOPR.

b. HCFC-Free. The Joint Comments also proposed additional classes for HCFC-free refrigerator products, both full-size and compact. The Joint Comments stated that treatment of HCFCs becomes a significant issue in the design of these standards because implementation of the new energy standards will occur less than five years before regulations promulgated by the Environmental Protection Agency (EPA), making HCFC–141b unavailable, become effective January 1, 2003. There is also concern that the date for phaseout of HCFC–141b may be moved up. Current data from Europe, Japan, and the U.S., provided by the Joint Comments, support approximately a 10 percent energy penalty in the shift from HCFC–141b to proposed hydrofluorocarbon and hydrocarbon substitutes. New technologies may be developed to reduce or eliminate the energy penalty, but it is impossible to forecast with certainty whether they will be commercially available by 2003. The Joint Comments proposed that new classes be established for any product employing non-ozone-depleting foam blowing agent which EPA approves under the Safe Alternatives Program of the Clean Air Act, or which uses blends or mixtures of less than 10 percent HCFC. (Joint Comments, No. 49 at 21).

The Environmental Protection Agency stated that, given the lack of a technology equal or better than HCFC–141b in terms of energy and ozone-depletion, EPA does not plan to phase out HCFC–141b any earlier than 2003. (EPA, No. 34 at 9). The Environmental Protection Agency also submitted a report entitled, ''Zero Ozone Depleting Blowing Agents for Use in Polyurethane-based Foam Insulations,'' which found that the high density, molded foam produced with the fluorinated ether, E245, has a thermal conductivity similar to that of CFC–11. (EPA, No. 34, Appendix 8 at 4). The report also states that the major problem with E245 is that it is not commercially available, and toxicity tests must still be conducted. (EPA, No. 34 at Appendix 8, p. 7).

The Department has considered all the viewpoints expressed concerning the impact of HCFC–141b phaseout on this rulemaking. The thermal conductivity of HCFC–141b product substitutes that may become available in the future is difficult to project. The following summarizes what is presently known about four potential substitutes:

- HFC–356 foam has a thermal conductivity of 0.126 Btu-in/hr-ft^2-°F (18.2mW/m-K), which is about 4 percent higher than the 0.121 Btu-in/hr-ft^2-°F (17.4 mW/m-K) conductivity of foams using CFC–11 [11]. HFC–356 has the advantage of being less aggressive toward liner materials than CFC–11. Toxicity testing is incomplete.
- The fluorinated ether E245 is nonflammable and may serve as a near drop-in replacement for CFC–11 and HCFC–141b. Foams using E245 as a blowing agent have been reported to have a thermal conductivity at 32°F (0°C) of 0.126 Btu-in/hr-ft^2-°F (25mW/m-K) [12]. It is not commercially available and will need to undergo toxicity testing.
- Cyclopentane has about a 10 percent higher thermal conductivity than CFC–11 blown foam. The conductivity could be lowered by about 5 percent with the addition of small amounts of perfluoralcanes (PFAs) [13]. Although pentanes are being used in Europe, the flammability of cyclopentane concerns U.S. manufacturers.
- HFC–365 and a blend of H–365 and HFC–134a have been tested as blowing agents and found to produce foams with similar thermal conductivities to CFC–11 [14]. As has occurred for HCFC–141b, DOE expects that the thermal conductivities of these new foams will improve as more experience is gained with their use in different formulations. In the analyses for these proposed standards, it was assumed that the thermal conductivity remained constant at 1993 values.

Based on the uncertainty of the availability of HCFC–141b replacements with equivalent thermal properties, the Department has decided to develop new product classes for products that do not use HCFC–141b or other HCFCs in the foam insulation.

2. Design Options. In the 1993 Advance Notice the Department requested comments on 30 design options it proposed evaluating for potential improvement of the refrigerator products. The comments received on each design option are discussed below. (Through the process of providing technical support for the informal negotiations of the Joint Comments parties, the Department was able to gain a better understanding of the issues relating to use of each of the design options considered. This has greatly improved the Department's ability to estimate the efficiency

[11] E. Ball and W. Lamberts. ''HFC–356, a Zero Ozone Depletion Potential (ODP) Blowing Agent Candidate for North American Appliance Foam Formulations,'' Proceedings of Polyurethanes World Congress 1993, Vancouver, Canada, October 1993, pp. 10–13.

[12] E. Blevins et al., ''Zero Ozone Depleting Blowing Agents for Use in Polyurethane Based Foam Insulations.'' EPA, No. 34, Appendix 8.

[13] U. Wenning. ''Hydrocarbons as PU Blowing Agents in Domestic Appliances'', Proceedings of 1993 International CFC and Halon Alternatives Conference,'' Washington, DC, 1993, pp 317–325.

[14] J. Murphy et al., ''HFC–365 as a Zero ODP Blowing Agent for Foams,'' Proceedings of 1993 International CFC and Halon Conference, Washington, DC, October, 1993, pp 346–355.