TECHNICAL BACKGROUND PAPER FOR
UTILITY AND PERFORMANCE RELATIVE TO
CONSUMER-PRODUCT ENERGY-EFFICIENCY STANDARDS
(FOR PROPOSED ENERGY-EFFICIENCY STANDARDS)
For use by the Freedom of Information Office
of the Department of Energy

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Prepared under Task VI of
Contract No. DE-AC03-79CS20315

For the
U. S. Department of Energy
Buildings and Community Systems Division
Consumer Products Efficiency Branch

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September 13, 1979

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ABSTRACT

This report is a summary of an investigation of the relative utility and performance of nine major household consumer products covered by the Energy Policy and Conservation Act. The objective of the investigation was to define the terms utility and performance, to recommend methods for quantifying these two concepts, and to recommend an approach for dealing with utility and performance issues in the energy efficiency standards program. The definitions developed are: Performance of a consumer product is the objective measure of how well, with the expected level of consumer input, the product does its intended job; and Utility of a consumer product is a subjective measure, based on the consumer's perception, of the capability of the product to satisfy human needs. Quantification is based on test procedures and consumer survey methods which are largely already in use by industry. Utility and performance issues are important in product classification for prescribing energy efficiency standards. The recommended approach to classification is: Prior to setting standards, evaluate utility and performance issues in the most quantitative way allowed by resources and schedules in order to develop classification guidelines. This approach to utility and performance issues and classification requires no changes in existing Department of Energy test procedures.

I. BACKGROUND

The Energy Policy and Conservation Act (Public Law 94-163), as amended by the National Energy Conservation Policy Act (Public Law 95-619), requires that the Department of Energy (DOE) prescribe energy efficiency standards for nine major household consumer products no later than December 1980.

Under the Energy Policy and Conservation Act (EPCA) of December 1975, the Federal Energy Administration was required to establish energy efficiency improvement targets and to develop test procedures for thirteen specified products. A fourteenth product category was established to include other products which use more than 100 kilowatt-hours annually. Energy efficiency improvement targets and final test procedures have been prescribed for the thirteen products and have been published in the Federal Register.

The National Energy Conservation Policy Act (NECPA) of October 1978 amended EPCA by replacing the energy efficiency targets with energy efficiency standards for the thirteen covered products as well as for any future products which come under this program. These minimum energy efficiency levels eliminated the requirement in the law of an aggregate efficiency improvement for the first ten covered products, but made it mandatory that each product or class of products have an energy efficiency equal to or greater than a minimum value to be established by DOE.

In Section 325(d) of EPCA, Congress mandated that standards requiring improvement of energy efficiency for the covered products are economically justified only if the benefits of imposing the standards exceed their burdens. This determination of economic justification is to be based upon a weighing of seven factors, one of which is any lessening of the utility or performance of the product. In combining the House and Senate versions of the bill, the conferees stated that the Secretary of Energy is expected to quantify these individual factors (such as utility and performance) to the greatest extent practicable. However, the Act provides little guidance as to how to quantify utility or performance nor does it define utility or performance.

The purpose of this project was to define the terms utility and performance, to recommend methods for quantifying these two concepts, and to recommend an approach for dealing with utility and performance issues in the energy efficiency standards program. The approach to dealing with utility and performance issues was to be considered within the context of nine priority products, for which standards are to be established by December 1980. These nine products are:

1. Refrigerators and refrigerator-freezers
2. Freezers
3. Clothes dryers
4. Water heaters
5. Room air conditioners
6. Home heating equipment, not including furnaces
7. Kitchen ranges and ovens
8. Central air conditioners, and
9. Furnaces

An Advanced Notice of Proposed Rulemaking (ANPR) Regarding Energy Efficiency Standards for these nine products was published in the Federal Register on January 2, 1979 (Ref. 1).

This summary of the results of this project on utility and performance was prepared under Task VI of the project, and is intended for use by the Freedom of Information Office of DOE.

II. RECOMMENDED DEFINITIONS

The definition of performance recommended for use in the energy efficiency standard program is:

Performance of a consumer product is the objective measure of how well, with the expected level of consumer input, the product does its intended job. Measures of performance include capacity and quality. Capacity can be stated in terms of thermal flux (in units such as Btu/hour) and either storage or working volume. Quality is a measure of the consistency (with time), uniformity (in space), or thoroughness with which the product does its job.

From the consumer viewpoint, the "expected level of consumer input" is the care and attention that the consumer is expected to provide by following the manufacturer's instructions for installation and operation. From the standpoint of the test program, the expected inputs are instructions similar to the manufacturer's which are codified into the test procedures. At minimum, the expected input should consist of those procedures necessary to keep the performance of the product from deteriorating.

Performance can be measured by prescribed test procedures, although not necessarily by existing DOE test procedures. The measures of the performance of a consumer product are typically few and do not change in time as long as external conditions (such as ambient temperature and electrical supply voltage) are not changed and the condition of the product has not deteriorated or otherwise changed. Thus, performance can be readily compared to a prescribed standard.

Table 1 shows the performance parameters which are measured by DOE test procedures for the nine products. The parameters which are

Table 1

PRODUCT PERFORMANCE PARAMETERS MEASURED BY DOE TEST PROCEDURES

<u>Product</u>	<u>Capacity</u>	<u>Quality</u>
1. Refrigerator and Refrigerator-freezers	Thermal capacity <u>Storage volume</u>	Temperature uniformity Temperature consistency Holding time
2. Freezers	Thermal capacity <u>Storage volume</u>	Temperature uniformity Temperature consistency Holding time
3. Clothes dryers	<u>Thermal capacity</u> <u>Working volume</u>	Temperature consistency
4. Water heaters	<u>Thermal capacity</u> <u>Storage volume</u>	<u>Temperature consistency</u>
5. Room air conditioners	<u>Thermal capacity</u>	Temperature consistency Temperature uniformity
6. Home heating equipment	<u>Thermal capacity</u>	Temperature consistency Temperature uniformity
7A. Cooking tops	<u>Thermal capacity</u>	Temperature consistency Temperature uniformity
7B. Ovens	<u>Thermal capacity</u> Working volume	Temperature consistency Temperature uniformity
8. Central air conditioners .	<u>Thermal capacity</u>	Temperature consistency
9. Furnaces	<u>Thermal capacity</u>	Temperature consistency

measured or can be calculated directly from measured data are underlined in the table. The parameters shown under capacity and quality are key measures of performance, which when specified numerically uniquely describe the basic performance of the consumer product; that is, its capability to do its intended job. There may be secondary measures of performance which are not listed in the table.

The definition of utility recommended for use in the standards program is:

Utility of a consumer product is a subjective measure, based on the consumer's perception, of the capability of the product to satisfy human needs. Energy efficiency and product performance as well as purely subjective factors can affect the consumer's perception of the product's utility.

Utility is inherently a subjective measure because it depends in part on the consumer's frame of reference, which can change with time. The utility of a product or an attribute of a product can vary from person to person as well as from time to time.

Utility can be measured using consumer surveys based on statistical methods although the values determined at any one time may not be the same as those determined earlier or later using the same methods.

A number of constraints affected the choice of these definitions of utility and performance. First, the definitions had to be compatible with the use of the terms in EPCA. To the degree possible, the definitions had to be compatible with the usage of the terms by the DOE program office and its contractors. They had to be compatible with use by the industry and by the public, as reflected in the public comments to DOE. The definitions had to be compatible with dictionary definitions such as that given by Webster's Third New International Dictionary, Unabridged (Ref. 2). Finally, the definitions had to lend themselves to the quantification of the two terms; in fact, they depend on ordinary test procedures, largely already existing (if not in DOE test procedures, then in the test procedures of standards organizations), and on consumer survey methods already in use by organizations which routinely poll consumer preferences.

III. RECOMMENDED APPROACH

The primary areas where utility and performance issues arise in the standards program are:

- a) weighing of the benefits of a standard versus possible lessening of product utility or performance, and
- b) creation of a class for models of a product with an attribute justifying an energy efficiency standard different from other models of the product.

The inverse of area b) is the elimination of models where a class is not created to accommodate the inherently lower energy efficiency of particular models of a product. The intent of the Act is not to force classes of products off the market, although this could happen if all models within a class are inherently energy inefficient to an unacceptable degree. In both areas a) and b), the consideration of utility and performance issues is to be done prior to issuing energy efficiency standards for the product. There are no provisions in the Act for continual monitoring of utility or performance, although there are provisions for re-evaluation of a standard not later than five years after it is prescribed.

Although there may be some lessening of the utility or the performance of the covered products resulting from the imposition of energy efficiency standards, this lessening should be small since manufacturers have little to gain by putting an undesirable product in the highly competitive market place for consumer products. On the other hand, failure to provide appropriate product classifications could eliminate from the market product attributes, features, or options which provide substantial utility to consumers. Thus class selection is the main route to insuring that there is no lessening of the utility or the performance of the covered products. The more general question of whether the imposition of a standard is justified or not can be addressed more appropriately by weighing the projected energy savings against the costs and other (of the seven) factors listed in the Act. The Act provides some guidelines as to what is considered significant energy use. In Section 325(a)(2) two minimum energy use levels are provided for the purpose of comparing to the energy use of products to be potentially covered under Paragraph (14) of Section 322(a). These two energy use levels are:

- o an average per household energy use of 150 kilowatt-hours annually, and
- o an aggregate household energy use within the U. S. of 4.2×10^9 kWh annually.

The recommended approach for handling utility and performance issues within the standards program is:

Prior to setting standards, evaluate utility and performance issues when creating classes. To the extent allowed by resources, schedules, and available data, this evaluation should be quantitative.

A further recommendation follows from this approach:

Do not change existing DOE test procedures for the purpose of acquiring data for defining classes and weighing the benefits versus burdens of proposed standards.

This recommendation concerning test procedures is based on the following facts:

1. The DOE tests are not the proper vehicle for acquiring utility data since utility is measured by consumer opinion surveys, not engineering test procedures;
2. Utility and performance data must be available before final energy efficiency standards are issued and, by implication, before the underlying performance tests are routinely run by manufacturers' or testing laboratories; and
3. There is no ongoing requirement for performance and utility data once the final standards are issued (except for the performance data acquired in the process of establishing energy efficiency by test).

IV. CLASS GUIDELINES

The central issue which requires consideration of utility and performance is the creation of appropriate product classes. The Act provides for the creation of a separate class for models of a product which

- "(A) consume a different kind of energy from that consumed by other covered products within such type (or class), or
- (B) have a capacity or other performance-related feature which other products within such type (or class) do not have, justifying a higher or lower standard from that which applies (or will apply) to other products within such type (or class). In determining under this paragraph whether a performance-related feature justifies the establishment of a higher or lower standard, the Secretary shall consider such factors as the utility to the consumer of such a feature, and such other factors as he deems appropriate."

In the January 2, 1979, ANPR (Ref. 1), 44 tentative classes were proposed for the nine priority products. The two criteria above were used as the basis for the selection of classes. The use of the words utility and performance in the public comments in response to this ANPR (Refs. 3 and 4) is overwhelmingly connected with product classification. Most addressing this issue recommended that the number of classes be expanded so that performance-related features and those providing utility not be eliminated from the market.

There is a need for a logical, consistent framework for answering such questions as:

1. How many classes should there be for the nine products?
2. What incremental improvement in utility is necessary to justify creating a separate class within a product type?

The following paragraphs outline an approach to answering this type of class-related question, once the decision has been made to issue a standard. This approach focuses on the utility of the product attribute to the consumer rather than the design or the underlying technology of the product; for example, the kind of energy consumed by the product or whether the attribute is an intrinsic part of the product or simply an accessory. The necessity for different classes for product models using different kinds of energy is clear from the wording of the Act. The assumption underlying this approach is that a separate class is justified to preserve the attribute in the market place if the value of the attribute in the eyes of the consumer is greater than its cost.

The example to be given is for the automatic defrost refrigerator-freezer, which was designated as a likely class in the January 2, 1979, ANPR (Ref. 1). This example is given because the utility of automatic defrost to the consumer was determined by Market Facts, Inc., in their 1977 consumer survey work for DOE (Ref. 5). Figure 1 shows the "utility" to the consumer of three levels of annual operating costs for refrigerators. Utility is shown in dimensionless, arbitrary units which were designated "utilities" by Market Facts. The measure of utilities is developed from aggregated consumer survey data and represents the intensity of consumer preference for a particular product feature. A smooth curve has been used to connect the three points determined by Market Facts. They also determined that the automatic defrost feature was worth 2.066 utilities to the consumer. From Figure 1, it can be seen that 2.066 utilities is equivalent to approximately \$40 in annual operating costs. Or said another way, reducing operating costs from \$75 to \$35 is worth 2.066 utilities. Thus it can be argued that the consumer is willing to pay 2.066 utilities, or \$40 in additional operating costs, for the convenience of the automatic defrost feature.

Automatic defrost requires an additional 95 to 450 kWh/year (see for example, Refs. 6-8). Based on the average cost of residential electricity in May 1979 (Ref. 9), 365 kWh/year (a typical value for a 16 cubic foot refrigerator-freezer) costs \$17.08 per year. One can now weigh the potential energy savings of eliminating automatic defrost (365 kWh/year or \$17.08/year) against the loss of utility to the consumer (1.066 utilities or \$40/year). Even without inflating the 1977

FIGURE 1. UTILITY OF AUTOMATIC DEFROST FEATURE FOR REFRIGERATOR

cost of \$40/year to 1979 levels, it is difficult to rationalize the elimination of a feature that is worth far more to the consumer (\$40/year) than it costs to operate (\$17/year). Thus one can conclude that the separate class for automatic defrost refrigerators should be maintained so that this feature will not be eliminated from the market by unattainable minimum energy efficiency levels. The fact that 60% of the refrigerators in existence have automatic defrost (Ref. 5) and that 77% of the refrigerators sold in 1977 had automatic defrost (Ref. 10) supports this conclusion.

The more rigorous approach to this example given would have been to develop a curve for purchase price similar to Figure 1 and then to convert both costs and values to their life cycle equivalent before comparing the two. (That is, 2.066 utilities is equivalent to some combination of incremental purchase value and incremental operating value, which can be converted to their equivalent life cycle value.) This was not done since it was obvious by inspection of the purchase price versus utility data that incremental purchase price was not an important consideration in the purchase of the automatic defrost feature (an increase of \$200 in purchase price was equivalent to only 1.052 utilities).

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