Interim Report

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UTILITY AND PERFORMANCE RELATIVE TO
CONSUMER-PRODUCT ENERGY-EFFICIENCY STANDARDS

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SUMMARY

This interim report summarizes work done under the third of six tasks of an investigation of the relative utility and performance of nine consumer products covered by the Energy Policy and Conservation Act. Task III consisted of developing definitions and methods for quantifying utility and performance based on interviews of people within the energy efficiency standards program and reviews of Federal Register notices and public comments on the program. 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 can be measured using consumer surveys based on statistical methods. Performance 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 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. Performance can be measured by prescribed test procedures.

I. BACKGROUND

This interim report summarizes the work done under Task III of an investigation of utility and performance relative to consumer product energy efficiency standards. The objective of the investigation is to define the terms utility and performance so that these concepts can be used to develop additional guidelines for the energy efficiency standards program mandated by the Energy Policy and Conservation Act (EPCA), as amended by the National Energy Conservation Policy Act (NECPA). The Act requires that the Department of Energy (DOE) prescribe energy efficiency standards for nine types of consumer products no later than December 1980.

Task III consisted of developing definitions for utility and performance and developing methods for quantifying utility and performance in the standards program and test procedures. The objective of Task III was to distill usable definitions and quantification methods from the information assembled in Tasks I and II. Task I, which was summarized in an interim report dated June 7, 1979, focused on the views of utility and performance held by DOE and National Bureau of Standards (NBS) staff involved in the standards program. Task II, summarized in an interim report dated June 21, 1979, consisted of reviewing DOE Federal Register notices and public comments received by DOE in connection with the standards program, test procedures, and energy efficiency improvement targets. Several related papers and reports were reviewed as well, and a public hearing on test procedures was attended. Task IV, scheduled to be completed by August 3, 1979, will consist of identifying significant issues, presenting and discussing options, and recommending an approach for handling utility and performance in the standards program.

Task III, which extended over three weeks, also involved reviewing several consumer guides and books on home economics to develop a better appreciation for the concerns which consumers have when selecting and purchasing a consumer product. These documents are listed in the bibliography. This consumer viewpoint is summarized in the next section. Some tentative conclusions are offered in Section III. The recommended definitions developed in Task III are presented and discussed in Section IV. Finally, an approach to the quantification of utility and performance is discussed in Section V, and an example is offered in Section VI.

II. CONSUMER VIEWPOINT

In public comments on consumer product features providing utility to the consumer, it was pointed out that the perception of the consumer as to the desirability of the features should be the basis for retaining such features. Another commenter said that "the paramount limiting variables in establishing classes are consumer utility and

product performance." Although, among DOE and NBS staff involved in the standards program and others working in the consumer product field, there seems to be some agreement as to what constitutes product performance; utility seems to be a more evasive concept. In order to understand better what features of consumer products are of interest to consumers (and by inference, provide utility), reports on products covered by EPCA were reviewed in the 1977, 1978, and 1979 Buying Guide Issues of Consumer Reports. Although this review does not constitute a survey of consumer attitudes and concerns, it does provide insight into what an informed consumer might be looking for when choosing and purchasing one of the covered products. Several other related documents (listed in the bibliography) were reviewed to round out this viewpoint. For each of the nine products, the features and performance parameters mentioned were listed and then divided into the categories: energy efficiency, performance, and subjective factors. Most reports mentioned energy use (or operating costs) as being an important consideration. Some mentioned type of energy or type of fuel as being a factor underlying operating costs. Both energy use and fuel type were considered related to energy efficiency, as shown in Table I, which summarizes the information obtained in this review. In the next category, performance, items which could be measured by prescribed test procedures were grouped; that is, any parameter which could conceivably be determined from information read from a meter (or meters) or other instrument was considered to be a measure of performance. Lastly, all other factors were grouped under the heading Subjective Factors. The subjective factors are not necessarily less important than energy efficiency and product performance, but they are typically more difficult to measure because they depend on the perception of the consumer as well as on the product. The parameters listed in Table I are not meant to be all inclusive but simply to represent the various types of consumer considerations.

A number of concerns applied generally to all products: purchase cost, seals of approval, reliability of dealer and manufacturer, guarantees and warranties, availability of servicing, construction (appearance, design, color, trim and size), hidden values (such as rustproofing), noise and heat generated, space required for use and storage, and operation directions. The choice of what particular model of a product best meets a family's needs is made keeping in mind such background as: health and energy of the homemaker, outside employment of the homemaker, attitudes of the family members, and number and age of children.

III. CONCLUSIONS

Based on the information assembled in Tasks I, II, and III, the following tentative conclusions are advanced:

1. All of the nine products are thermal devices;
five simply convert energy input into usable

TABLE I. CONSUMER CONSIDERATIONS

PRODUCT	ENERGY EFFICIENCY	PERFORMANCE	SUBJECTIVE FACTORS
Refrigerators and refrigerator-freezers	energy use	storage volume, cooling capacity, spatial temperature uniformity	reliability, ease of cleaning, storage arrangement, defrosting, convenience
Freezers	energy use	spatial temperature uniformity, holding time, temperature swings	storage arrangement, defrosting, ease of cleaning
Clothes dryers	energy use, fuel type	temperature swings, speed, size of load	safety, convenience, features, treatment of delicate/permanent press fabrics
Water heaters	energy use, fuel type	storage capacity, recovery time	corrosion resistance, safety, features, ease of installation
Room air conditioners	energy use	cooling capacity, temperature swings, 120 or 240 volts	convenience, ease of installation, repair
Home heating equipment			safety, convenience, features
Kitchen ranges and ovens	energy use, fuel type	temperature swings, speed, spatial temperature uniformity	safety, ease of cleaning, features, convenience, durability, control layout
Central air conditioners	energy use	correct sizing	
Furnaces	energy use, fuel type	correct sizing	safety, comfort

thermal energy, and four are Carnot limited machines which use shaft work (usually derived from electrical input) to move thermal energy from a lower to a higher temperature. (This conclusion is not true for three of the four additional products covered by the standards program, however.)

2. Since each of the nine products is a thermal device, one measure of its performance is capacity in terms of an energy flux (Btu/hour or a similar measure). Storage volume in cubic feet (or a similar measure of volume) or working volume is a further capacity measure for some of the products (such as refrigerators or freezers).
3. For some of the products a further measure of performance can be stated in terms of a "quality" parameter; for example, spatial temperature uniformity in a refrigerator.
4. All of the parameters in the Performance column of Table I can be viewed as either a measure of "capacity" or "quality".
5. The existing DOE test procedures for energy efficiency all include provisions for determining at least one measure of capacity. In general, they do not include provisions for determining measures of quality (where applicable to the product).
6. Most of the nine products cycle on and off to meet the load imposed; that is, they are either running at full load (not necessarily design point) or they are off. Some of the products have modulating controls (for example, a gas oven) and some are uncontrolled; that is, they run open-loop (for example, some burners on gas ranges).
7. It is impossible to characterize all of the parameters listed in the Subjective column of Table I by rigid (or deterministic) models; that is, the variables are not related in precise mathematical terms from which values may be determined exactly. Rather, it is necessary to consider the statistical nature of the variables.
8. The potential list of subjective factors is almost endless. These factors can vary in their "degree

of subjectivity" from the purely subjective (such as status connotation) to those where the underlying physical features of the product are very important (such as corrosive resistance). Or said another way, subjective factors can be based on both tangible and intangible considerations. All of these factors are subjective because they cannot be assigned values in isolation from the consumer's thoughts and feelings. A product viewed by one consumer as having "adequate" safety might be viewed by another consumer as having "inadequate" safety. There is simply no objective scale of safety, which exists apart from a person's perception.

IV. RECOMMENDED DEFINITIONS

The definition of utility recommended for use in the standards program is: Utility of a consumer product is a subjective measure of the capability of the product to satisfy human needs. It 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 product's feature can vary from person to person as well as from time to time. At any time, utility can be measured by surveys, although the values determined may not be the same as those determined earlier (or later) using the same methods.

The consumer's perception of the utility of a consumer product can be based on energy efficiency and product performance as well as the subjective factors discussed in Section II. Utility is the consumer's interpretation of how well the product satisfies his or her needs and is based on his or her reaction to any of the possible factors included in the three categories: energy efficiency, performance, and subjective factors.

Performance of a consumer product is the 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 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. Each product has one or more measures of capacity and one or more measures of quality.

From the consumer's viewpoint, the "expected level of consumer input" is the care and attention that the consumer is expected to provide if he or she follows the manufacturer's installation and operation instructions (whether they be called instructions, specifications, directions, recommendations, suggestions, comments, tips, or hints). From the standpoint of the test program, these instructions should be codified into specifications or test procedures. At a minimum, the "expected input" should

consist of those procedures necessary to keep the performance of the product from deteriorating. For example, some instructions gleaned from a manufacturer's guide for an electrical clothes dryer are:

1. Install to exhaust outside.
2. Do not exhaust into a chimney.
3. Sort clothes for washing and drying according to fabric, color, construction, etc., and set dryer temperature and timing controls accordingly.
4. Clean lint collector frequently during use.

Quality, like capacity, can be measured using prescribed test procedures. In order for the tests to produce reproducible results, certain parameters (such as ambient and set point temperatures) have to be specified as fixed. Although quality can be measured objectively, the more common views of quality are subjective; for example, evenness of baking (as opposed to spatial temperature uniformity).

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 voltage) are not changed and the condition of the product has not deteriorated or otherwise changed. Thus, the measures of performance can be readily compared to a prescribed standard (which is not necessarily the case with utility).

V. APPROACH TO QUANTIFICATION

Since the measure of the utility of a consumer product necessarily includes the consumer's reaction to the product, any quantification method must include the consumer's views. A survey using statistically designed samples appears to be the most straightforward way of measuring the utility of a product and of its features. An arbitrary scale could be developed so that the various features of a product could be numerically compared. (Market Facts, Inc., used the unit of "utility" in a consumer survey of appliance attributes.) The design of the survey questionnaire would depend on exactly what data is to be developed by the survey. It would seem that the following kinds of information, at minimum, might be useful in assessing the utility of a product:

1. The importance to the consumer of the
 - o purchase cost
 - o operating costs
 - o performance, and
 - o convenience featuresof the consumer product;
2. Demographic information; and
3. Household consumer product ownership--past, present and planned.

Since performance is based on variables which are related in precise mathematical terms and since the measures of performance are few for any one product, measuring performance should be easier than measuring utility. In general, prescribed DOE test procedures require the determination of a capacity figure(s) as part of establishing energy efficiency. The test procedures detail the parameters which must be held fixed and their values during the test. However, measures of "quality" are not generally developed during the determination of energy efficiency.

The most straightforward way to obtain performance measures for a consumer product appears to consist of using the capacity figures developed during the energy efficiency tests and prescribing additional tests to measure the quality of performance (if the measurement of performance is, in fact, necessary to carry out the intent of the Act).

VI. AN EXAMPLE

The following illustration is based on the "Proposed Rulemaking for Central Air Conditioners." Specifically, some of the key parameters from Test A for air source cooling only units with single speed compressors and single speed condenser fans are used to illustrate the ideas of capacity, quality, and fixed conditions.

Capacity measured: Total steady state wet-coil cooling capacity in Btu/hour.

Quality measured: Not measured as such; specified testing operating tolerances are 2°F (total observed range) for leaving indoor dry bulb and 1°F for indoor leaving wet bulb temperature.

Fixed conditions: Outdoor dry bulb temperature, 95°F
Outdoor wet bulb temperature, 75°F
Indoor dry bulb temperature, 80°F
Indoor wet bulb temperature, 67°F

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