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Barriers Connected with Certifying or Listing of Energy-Conserving Products Used in Buildings

**Work Performed Under Contract
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Hittman Associates, Inc.
Columbia, Maryland 21045

Energy Research and Development Administration

Division of Buildings and Community Systems

MASTER

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HMT-680

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Prepared for:
Division of Buildings and Community Systems
Office of the Assistant Administrator for Conservation
Energy Research and Development Administration

Prepared by:
Hittman Associates, Inc.
Columbia, Maryland 21045

May 1977

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PREFACE

We believe that certifying and listing organizations as well as standards developing organizations provide a valuable service to the public and to the economy. If anything, the private sector probably underinvests in standardization, certifying, and listing efforts. It is not the intent of this report to lead the reader to think otherwise.

In performing this work we obtained information from as many sources as possible within the framework of this contract and attempted to process this information as accurately as possible in presenting an overview of the certifying and listing processes, and in arriving at conclusions and recommendations. These sources were chosen to represent not only certifying or listing organizations but all the parties involved in the certifying and listing processes. To the extent that we were able to obtain the information we sought, this effort, we believe, has resulted in the balanced overview sought. This is not to say that no further work is needed. In many cases, it was not possible to obtain specific numerical data, such as the cost of testing and certifying, from a large number of organizations such that a high level of confidence, in a statistical sense, could be achieved. Thus, the numerical data provided in the report should be viewed as representative estimates rather than as precise statistical quantities.

The conclusions presented were meant to be generic in nature so it must be appreciated that not all the conclusions apply specifically to any single organization. In fact, some of the major certifying and listing organizations deviate considerably from the generic picture which we have provided in the report.

This program was sponsored by the U.S. Energy Research and Development Administration. The suggestions, support, and guidance of Patrick Reynolds, Government Technical Representative, are acknowledged with sincere thanks.

The assistance of Building Technology Incorporated is gratefully acknowledged. Special mention must go to Thomas Ware for his help in guiding this effort and for providing insight concerning building products and codes.

We are particularly grateful to the Workshop participants, listed in Appendix E, who gave of their time and knowledge to assist us in trying to make the outcome of this project as practical as possible.

Thanks also go to members of the Hittman Associates, Inc., staff who contributed their ideas and efforts to this work. In particular, we would like to thank Harvey Bernstein and Jack Overman, who helped plan the program; James Reed, who coordinated the drafting of the final report; and Barbara White, for her assistance in preparing the manuscript.

We have not listed the others who have contributed in one way or another to this project, not because we have taken their generous assistance for granted, but rather because they are so many.

James L. Coggins
Kenneth W. Boras
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I. INTRODUCTION AND SUMMARY

In striving to achieve the national goal of positively and effectively conserving energy supplies, it is necessary to evaluate and assess the availability and implementation of energy conservation technology. Of particular concern is the availability of energy conservation technology for use in the residential sector, since this sector accounts for one-fifth of the national energy use.

There is no lack of residential energy conservation technology. There is a large disparity between the rapid rate of technological progress and the slow rate of implementation in this complex marketplace. Of concern is that energy conserving innovations are restricted, and in some cases, blocked entirely from reaching the marketplace by a variety of institutional barriers. In particular, it is suspected that innovations offered by independent inventors and small manufacturers are not reaching the marketplace.

The U.S. Energy Research and Development Administration (ERDA) has begun to focus on these market restrictions in an attempt to develop programs and policies to mitigate these barriers. As part of this effort, ERDA sponsored a project to examine the market restrictions connected with the certifying and/or listing of energy conserving products used in residential structures. The project focused on fully developed products whose market penetration was being restricted by certifying or listing practices and procedures. The overall objective of the project was to identify practical policy or program options whose implementation would increase the rate and degree of market penetration of these products. The results of this project, which was performed by Hittman Associates, Inc., (HAI) over a five month period, are summarized in this report.

The barriers of concern were any type of constraint on market penetration of energy conserving products connected with the practices and procedures of the certification and listing processes. Constraints primarily associated with building codes were not the primary focus here, in spite of their recognized relationship to the certifying and listing processes. Constraints associated with the certification and listing processes were identified as resulting from several features of the existing certification and listing system. These features are summarized as follows:

Institutional. Barriers arise due to the nature of an institution. Institutions connected with the certification and listing process considered for this study

are: manufacturers, certification and listing organizations, professional and technical societies, standards making organizations, financial organizations, government agencies, and consumer groups.

Due Process. The steps that must be taken to obtain certification or listing create barriers.

Testing Criteria. The testing procedure and criteria against which the product is tested can cause barriers to arise.

Standards Development. The manner in which a standard is developed can be a barrier.

Economics. The costs associated with certification or listing can be significant.

Legal. Mandates (laws) related to certification or listing practices and procedures cause barriers.

The products of concern during this project were those energy use-related products purchased by developers/builders, contractors, and building owners, for use in any type of residential building. The report is specifically concerned with residential energy use-related products in these categories: building services (mechanical equipment and components), structural and architectural components, and major appliances.

Examples of already developed energy conserving products identified as having certification or listing problems include:

- flue gas dampers,
- heat-only heat pumps,
- electric instantaneous water heaters,
- infrared quartz space heaters,
- urethane insulation, and
- flue gas heat recovery devices.

Many other effective energy conserving products were identified during the course of this study but are not reported upon because: (1) they fell outside of the established product classifications, or (2) they appeared to have had minimal problems with the certification or listing processes.

In the United States, there is no legal requirement for testing and approval of new technologies. Testing and certification for the building industry is performed by independent laboratories using consensus standards developed by voluntary agencies.

The voluntary agencies are made up of representatives from government and industry, manufacturers and consumers, and institutions and individuals. The agencies are voluntary in that participation of interested parties is on a voluntary basis. Compliance by manufacturers with the developed standards is also "voluntary." The developed standards are intended to provide a level of reliability in manufactured products in the building industry. This level of reliability is often codified in building codes.

In contrast with voluntary standards, building codes are legal documents that set forth construction standards to protect the health, safety, and general welfare of the public. Building codes often require that products exhibit certification of compliance with voluntary standards. Even when not absolutely required by code regulations, building officials often require component certification as a condition of passing inspection.

The government influences the standards development, testing, and certification processes through its own writing of specifications. One of the best examples of listing is the General Services Administration's list of products acceptable for purchase by the Federal government. Special-interest groups list in their journals products that have met recognized standards or have been tested by a recognized certifying or listing institution. Also, some consumer magazines list products that are in compliance with nationally recognized standards. Product listings convey to the purchasers of various products that the specified products are in compliance with recognized standards and thus safe within the limits of intended product use.

The following sections of the report describe:

- the results of a survey of energy conserving products and certification practices and procedures;
- energy conserving products identified as being restricted by certification and listing practices and procedures;
- the identification and analysis of the effects of these barriers; and
- the recommendation of policies and programs to mitigate the effects of the identified barriers.

II. CONCLUSIONS AND RECOMMENDATIONS

The key conclusions resulting from this project are:

- Certification and listing practices and procedures appear to be a greater obstacle for small manufacturers and inventors due to their limited resources.
- From our survey of products, only a few energy conserving products appear to be highly affected by certifying practices and procedures.
- The total energy conserving potential associated with the products identified by this project amounts to an estimated three percent of the nation's cumulative residential energy usage by 1990.
- In recent years the Federal government's role has been reduced in private sector standards development and in certifying and listing practices and procedures.

The most serious barriers associated with the certifying and listing process (as developed generically in Chapter VI and more specifically in the Workshop described in Appendix F) appear to be:

- Lack of an information source on how to use the certifying system.
- A limited number of nationally recognized certifying laboratories.
- Costs of testing and certification.
- Absence of nationally recognized performance criteria.
- Product liability.
- Length of time required for certification.

The key recommendation of this project is that one or more of the following programs be implemented:

- That a Federal office be created to disseminate information using easily updated and readily accessible methods such as:
 - Toll free telephone number,
 - Referral Office with a computer based center,

- Pamphlets,
 - National Technical Information Service-type office,
 - Regional information offices (county agent-type programs),
 - Technical and business magazine articles, and
 - Other appropriate methods.
- That the Federal government encourage the development of a private sector office to disseminate information using an easily updated and readily accessible method (such as those suggested in the previous program), charging a minimal fee for this service. This office should be supported by the institutions who currently develop standards, certify and list products.
 - That the Federal government accredit certification and listing agencies, thereby encouraging the development of more certifying agencies.
 - That the Federal government encourage the voluntary restructuring of existing certification and standards development systems to reduce ambiguities and redundancies in order to make uniform the procedures used by similar certification and standards development agencies. As a distinct preliminary stage to the implementation of such programs, the Federal government should initiate feasibility studies to examine the probable success of modifications to the existing system.
 - That the Federal government initiate an insurance program funded by the payment of premiums to protect certification and standards development agencies from liability of malfunctioning certified products. This type of insurance might be provided by an existing insurance company or by the Federal government.
 - That the Federal government subsidize - through loans - manufacturers seeking certification and listing of new and innovative products. A loan should be made available to manufacturers of new and retrofit products seeking certification and listing. The loan should not exceed a designated fraction of the total cost for certification and should be made payable when the firm becomes a solvent producer of the product.

- That the Federal government subsidize - through grants - standards development committees. The Federal government should make funds available to a standards development committee for the development of a standard, if required, for the certification of a product. Also, a committee to review the associated costs of standard development should be created.

A summary matrix of all the identified programs has been included as Table VII-1 at the end of Chapter VII.

III. SURVEY OF ENERGY CONSERVING PRODUCTS AND CERTIFICATION PRACTICES AND PROCEDURES

To address the stated objective of identifying market restrictions attributable to the certification or listing of energy use-related products utilized in residential buildings, certain background information is needed. The information presented in this chapter provides this background. Using extensive literature review and contacts with individuals who have participated in the certification or listing process in various capacities, it has been possible to identify and discuss each of the following:*

- (1) Energy Conserving Products used in Residential Buildings,
- (2) Certification and Listing Agencies, and
- (3) Certification and Listing Practices and Procedures

This initial information base makes it possible to perform an analysis exploring the relationship between the market penetration of new or innovative products and the restrictions identified as precipitating from the certification or listing process.

A. Survey of Products

The following section presents the results of a survey of energy using and energy conserving products used in the residential housing sector. Appendix A lists those references surveyed. All significant energy-related products have been included, along with a brief description of each product and its energy saving potential. Products used in both new and existing buildings have been included. It should be noted that two distinct classes of products (as related to energy conservation) have been surveyed, those being:

- Energy using products - primarily intended to provide a service unrelated to energy conservation - that have associated potential energy savings only through modifications resulting in higher product "efficiencies." For example, a consumer purchases a television set for viewing entertainment, but he can buy one that has an instant-on defeat switch to save energy while on vacation.

* *Note that Literature Review information and Contact Lists have been included as Appendices A and B.*

- Energy conserving products that are purchased almost exclusively for the purpose of reducing household energy use. Examples of this type of product include insulation, storm windows, and flue dampers.

These two types of products are subject to very different design and purchase criteria. Whereas the value to the consumer of conservation-type products is directly - and almost exclusively - related to those products' energy savings, the value of energy using products is much more a function of other, energy-exogenous, considerations. In fact, it frequently results that an energy saving modification in an energy using product requires a reduction in the level of service it provides, or an increase in the initial cost of the product. This trade-off may not be desired by the consumers, and this consumer non-acceptance is often anticipated by the producer to be strong enough to preclude the implementation of the energy conserving modification in the product's design.

To increase the continuity of the survey, the products discussed are grouped in three broad categories:

- Building services, which includes all HVAC systems and mechanical components;
- Structural and architectural components, including insulation, windows, weather stripping, and the like; and
- Major appliances, such as televisions, water heaters, etc.

All products in the major appliance category fall into the energy-using group, and any potential for energy savings in this group must be considered in light of decreased consumer acceptance, as stated above. The structural and architectural component products mostly fall into the energy conserving category, and therefore reduced home energy use is their basic reason for installation (comfort is a secondary consideration in some cases). The building services products fall into both categories. While a particular residential HVAC system is primarily designed to heat, cool, and ventilate a building, many component products are available that, when added to the system, reduce the system's energy use.

1. Building Services Products

Component products in this class are associated with: heating systems, cooling systems, and combined (heat pump) systems, and are discussed below in that order. Since approximately 60 percent of all energy used in the residential sector is for heating and cooling, building services products have an extremely large potential for significant future reduction in national energy use.

a. Heating System Products. Gas fired furnaces presently are employed in the majority of the residential structures in the U.S. and recent building trends do not indicate that this domination is soon to change. There are five major losses related to the operation of conventional gas-fired furnaces which cause the seasonal efficiency for a furnace to range from 45 percent to 65 percent. These losses include:

- (1) operating stack loss,
- (2) jacket loss,
- (3) cyclic loss,
- (4) pilot light loss, and
- (5) infiltration loss.

The operating stack loss is defined as the ratio of the flue losses (during actual furnace operation) to the energy input of the fuel, and is usually about 25 percent of the input energy. Problems of condensing water vapor and ensuing acid formation in the flue may arise from attempts to reduce stack losses. There are two methods to reduce the operating stack loss, which are (1) more efficient energy transfer from the fuel to the conditioned air, and (2) the implementation of a heat recovery device in the flue. Operating stack losses can be reduced up to 20 percent through the design of more efficient burners and improved heat exchangers without creating any flue problems. A heat recovery device can be placed in the flue to transfer heat from the flue gases to the conditioned air. The device can lower the operating stack loss to a range of from 13 to 21 percent (Refs. 17, 18, 19, and 20).

The jacket loss is very small and the potential energy savings which may be attained are therefore small (Ref. 18).

The cyclic loss, which can be as large as ten percent of the total energy used by the furnace, is defined as the ratio of the energy losses due to start and warm up operations to the total energy used. The cyclic losses are due to the cooling of the heat exchanger, and can be affected by fan (or pump) temperature settings. The cyclic losses may be reduced to about two percent by lowering the temperature setting for the fan (Ref. 18). The potential energy savings

for the cyclic losses is also dependent upon the type, capacity, and proper sizing of the furnace to the actual operating conditions. Cyclic losses of a different type are caused by conditioned air being lost up the stack while the furnace is not operating. A moderate wind speed can cause large exfiltration losses through the flue. A motorized or differential pressure stack damper can be used to seal the flue during furnace down time, thus reducing the heating load (through reduced exfiltration of warm air) in single-family residences and town houses by up to 20 percent (Refs. 21, 22, and 23). The savings are much smaller in large apartment type structures, since the furnace is typically more isolated from the conditioned space.

The pilot light losses range from 5 to 19 percent (Ref. 23), and can be eliminated by the installation of an electric ignition device. An electric ignition device ignites the pilot light only when the furnace is to be ignited. As a safety precaution, a sensor is provided which prevents gas flow to the main burners unless the pilot light is burning.

Conventional furnaces are naturally aspirated and draw the required combustion air from the surrounding conditioned air space. Infiltrating air replaces air used in combustion, and can represent up to ten percent of the total infiltration load for the residence. There are two methods to reduce the infiltration loss. The outside air can be directly vented to the furnace for combustion, or the furnace can be located outside the structure. Either of these methods eliminates the infiltration loss, which may result in energy savings on the order of five to seven percent (Ref. 18).

Other factors affect the seasonal efficiency of a furnace. The majority of furnaces are not properly sized to meet the peak heating load. In many installations, the furnace capacity is oversized by a factor of two or more. The installation of a properly sized furnace could reduce the annual heating energy requirement significantly. The energy savings for houses which have been retrofitted with better thermal insulation can be enhanced by the installation of a new, properly sized furnace which is based upon the reduced peak heating load of the thermally improved house.

Innovative gas-fired furnace designs may have the potential to conserve energy. One manufacturer is currently marketing a furnace that has a unique burner. The furnace is located outside the house and the exhaust gases are released directly to the environment. The burner is smaller than conventional units and has improved heat transfer properties. The potential energy savings for

this unit are up to about 19 percent in comparison to conventional, naturally aspirated gas furnaces (located inside the residence) (Ref. 23). Another innovative design is a pulse combustion furnace. From 1956 to 1958, pulse combustion boilers were manufactured for residential hydronic space heating systems.

The design of conventional oil-fired furnaces is very similar to that of gas-fired furnaces. Many of the improvements for gas-fired furnaces are applicable to oil-fired furnaces as well, and the potential energy savings are also very similar. The operating condition of an oil-fired furnace is more critical than for a gas-fired furnace, thus annual maintenance is more important to minimize energy use. One technical option that may be implemented for oil-fired furnaces is the use of emulsified fuels. The fuel is a mixture of oil and water or methanol. The fuel mixture can be emulsified by (1) mechanical mixing, (2) ultrasonic emulsification, or (3) spray techniques. Current research has developed an ultrasonic cavitation technique to produce water-in-fuel emulsion immediately before combustion. There are advantages for the application of these fuels in residential oil burning furnaces. The excess combustion air would be reduced by about 50 percent, and also would have lower particulate emissions. The surface of the heat exchanger would have fewer carbon deposits. The conclusions of contemporary studies indicate that increased oil furnace efficiencies could be attained by significantly reducing air and fuel flows. These potential energy savings could be realized by the application of emulsified fuels in residential furnaces (Refs. 24 and 25).

Electric furnaces and baseboard radiation heating units are very efficient (about 0.9 for furnaces and 1.0 for baseboard heating) for converting electricity into heat. However, the gross inefficiencies associated with generating electricity must not be overlooked. Only about one third of the energy used at a generation plant is converted into electricity. For this reason, any electrically powered heating device must be very efficient to be favorably compared to fossil fuel fired furnaces in terms of total energy requirements.

One such device is a heat pump. Typically a heat pump also includes an air conditioning cycle, and these units are discussed in Part C of this section. However, several manufacturers are presently developing a heat-only heat pump that, due to its specialized applications, can reach a C.O.P.*

* *Coefficient of Performance*

of as high as 3.2 for heating. Such a device can out perform fossil fuel furnaces under some conditions, but the C.O.P. drops significantly with lower temperatures, and on the average, the unit still uses more energy than the fossil furnaces do.

A second alternate use of electricity for heating involves the use of infrared space heaters. Unlike conventional heating systems which transfer heat to bodies in the conditioned space by heating the air in that space, an infrared system radiates the heat directly to the objects in the room. This method reduces the heating load caused by infiltration and transmission through the building skin and can save up to 40 percent of the energy used in a conventional electric system (Ref. 27).

b. Cooling System Products. The cooling process can best be understood by describing what occurs in a typical room air conditioner. When the temperature in a room to be air conditioned is above the setting of the thermal element in the air conditioner, the element activates the motor controls for the compressor motor, the condenser fan, and evaporator blower motor. The blower draws warm air from the room over the cold evaporator cooling coils and discharges the same air, now cooler, back into the room. The air, in passing over the evaporator coils, gives up some of its heat to the cold (about 40°F) low pressure liquid refrigerant in the evaporator coils, causing it to vaporize. The vaporized refrigerant then flows through a suction line and into the compressor. The compressor compresses the vapor and raises its temperature to about 130°F, and discharges it to the condenser. Outside air is drawn into the outer compartment by the condenser fan, which forces it over the hot condenser coils, causing the outside air to absorb heat from the hot high pressure refrigerant vapor in the coils. The refrigerant, after an expansion process, flows through the liquid line to the evaporator coils. The cycle is repeated until the thermal element has been cooled to a preset temperature, at which time it deactivates the motor controls for the compressor and the fan and blower motors.

It should be noted that cooling the air in a room by an air conditioner occurs only when the compressor is running. Some air conditioners have a high and low speed control for the blower and fan; the cooling capacity of the air conditioner and the air flow volume are decreased when the low speed is used.

The design and placement of the various components of an air conditioner, such as coils, fan, blower, motors, and compressor are extremely important factors influencing its overall efficiency. Generally, it may be expected that, given two different sized room air conditioners with the same input voltage and total cooling capacity, the larger air conditioner will contain a larger condenser, a larger evaporator, and a larger-than-usual compressor, and be quieter, more efficient, heavier, and costlier than the smaller one.

Many apartment buildings use enough electrical energy, which is converted to heat within the building, that the building needs to be cooled even though the outdoor temperature is lower than the indoor temperature. In such situations, it is advisable to use 100 percent outdoor air for cooling, and exhaust all of the return air, rather than recirculate part of the return air and mix it with some outside air. This is known as an "economizer" cycle. One of the aspects of this type of system is that if the controls for the system sense only dry-bulb temperature, the use of outside air can, in some cases, be wasteful of energy since the compressor may run in some cases to provide cooling which could have been provided by unusually dry, low enthalpy, outside air whose temperature is above the dry-bulb set point. If the system is controlled by an enthalpy sensor, which takes into account both the dry-bulb temperature and the moisture content of both the return air and the outdoor air, then the economizer cycle will only operate when it is, in fact, saving energy.

The range of conditions under which an economizer cycle can operate may be expanded if the HVAC system is designed so that return air also picks up excessive heat, such as that given off by lights. In this type of system, the internal loads are intercepted before they enter the space as a cooling load, and increase the temperature of the return air. The increased temperature of the return air allows an economizer cycle to provide savings even if the outdoor temperature is slightly higher than the indoor temperature.

c. Heat Pumps. A heat pump uses electricity to drive a compressor which extracts heat from a low temperature reservoir and transfers the heat to a high temperature reservoir (the operation explained in detail for air conditioners). One unit may be used to both heat and cool a building by simply reversing the pump direction.* This

* In the winter, heat is pumped into the structure, while in the summer, heat is pumped out of the structure.

process typically uses about one-half of the primary energy required by electric resistance heating under favorable operating conditions. It should be noted that, as discussed above, large energy losses are associated with electricity generation - this process being on the order of 30 percent efficient. Therefore, the energy use of any electrical heating system must be less than one-third that of an oil or gas fueled system to compare favorably on a total energy use basis.

Theoretical analysis shows that the C.O.P. of a heat pump is dependent upon the temperature differential between the low and high temperature reservoirs, and that the C.O.P. will decrease as the temperature differential increases. Therefore, the performance of the heat pump declines as outside air temperatures drop below 32°F. There are three reasons for this degradation: the coefficient of performance (C.O.P.) is lower, additional energy requirements are needed for defrosting operations, and the change in mechanical properties induce lower efficiencies. Performance also decreases during cooling when the outside air temperature rises above 80°F.

The major mechanical problems that affect the performance of a heat pump are the:

- compressor,
- working fluid, and
- maintenance of controls, filters, exchangers, and coils.

A typical heat pump compressor has a hermetic design, which has a high reliability for cooling applications. However, when used for heating, the compressor operates under greater stress levels at low (32°F and below) ambient temperatures. The welded hermetic compressor will develop temperatures near 275°F in the discharge line. The compressor oil will decompose and create acids at 350°F. The welded compressor has poor heat transfer properties, and common practice has been to flood the compressor with liquid refrigerant. The quantity has to be carefully controlled to allow sufficient liquid refrigerant to cool the compressor, and to avoid large flows that will create lubrication and mechanical problems. A compressor has been developed which will operate favorably under the low temperature heating conditions of a heat pump. The new compressor will not develop high temperatures and does not require the periodic flooding of liquid refrigerant. However, this compressor is about twice as expensive as the conventional welded hermetic design. Low maintenance costs and longer life may justify the added expense (Ref. 17).

The working fluid in most heat pumps is Freon R-22. This refrigerant performs favorably overall, even though it is not as effective as other refrigerants in heating. Either of two refrigerants (R-12 and R-502) could improve heat pump performance in the low temperature heating mode, at the expense of cooling performance. In addition, R-502 is less expensive than R-22.

More efficient components, such as compressors, motors, and fans represent a low level of improvement to heat pumps. A high level of heat pump improvement can be attained with an additional compressor unit. The following cycles represent some of the ways that two compressors may be used to increase the efficiency of a typical heat pump:

- parallel compression,
- cascade operation,
- series compression, and
- two staged.

Parallel compression is a relatively easy method to increase heat pump capacity. Each compressor can be sized differently, and be separately controlled to match the heat pump output to the demand. Cascade cycles use two compressors and two different refrigerants, and can increase the heating capacity. Each compressor operates over half of the temperature range and at a relatively high level of efficiency. Series compression reduces the mechanical and operating losses associated with low temperature heating. The two-stage cycle may also be used to reduce these mechanical and operating losses.

It should be noted that although mechanical improvements offer substantial energy savings, proper heat pump installation alone can result in a significant reduction in energy use.

d. Other Components. Several other residential building service components can give energy savings.

A recirculating kitchen fan reduces the infiltration load for both heating and cooling by filtering and recirculating kitchen air rather than exhausting it to the outside. This can save from two to five percent of the heating energy used in a structure (Refs. 29 and 30).

Attic ventilation units are said to reduce cooling loads, but the increased infiltration load may negate a large part of their benefit. If used only at night when the outdoor temperature is cool, an attic ventilation unit will reduce the cooling load by up to 30 percent (Ref. 27).

2. Structural and Architectural Components

These products are used to reduce building heating and cooling loads by increasing the thermal barrier presented by the building to the outside environment. Products in this category fall into four sub-classes:

- glass products,
- insulation,
- caulking and weather stripping, and
- other building components.

Each sub-class is discussed below.

a. Glass Products. Storm windows have been cited by the National Bureau of Standards as the one insulating component that saves more fuel dollars than any other component. This statement was based on a test house in which the NBS engineers monitored different energy saving measures using infrared photography. Storm windows reduce the energy requirement of a structure in two ways:

- (1) they reduce infiltration of outdoor air through the window perimeter by increasing the resistance to air flow through the cracks between the window sash and the frame, and
- (2) they create a relatively immobile air space between the primary window and the storm window, which increases the insulating ability of the window.

The addition of storm windows will typically reduce infiltration around the window by about 15 to 30 percent. Storm windows will also reduce the conductive heat loss through the glass area by about 50 percent. The combined effects of reduced infiltration and increased insulation resulting from the addition of storm windows can represent a total savings of fuel for heating and cooling of 10 to 25 percent in typical residential buildings (Ref. 28). The exact savings achieved by any particular installation will depend on the characteristics of the building, the quality and type of materials used, and the installation workmanship.

The types of storm windows installed vary widely - from a plastic sheet taped over a window to a permanently installed system which allows for opening of the storm sash and sliding a screen into place over the opening during the summer months. In any type of storm window, the benefit gained will be affected by the quality of the product and the workmanship of the installation. If large cracks are left around the perimeter, the window will be less effective in reducing infiltration.

While windows typically comprise five to eight percent of the total envelope area of a residential building, they account for nearly 30 percent of the conductive losses. A double-glazed window can reduce the conductive losses through the glass area by about 50 percent (Ref. 27). The reason for this large decrease in heat loss becomes clear if one examines the mechanisms through which heat is conducted through windows.

Figure III-1 shows the components through which heat must flow for both single- and double-glazed windows. Figure III-1A shows that, for single-glazed windows, almost all of the thermal resistance is in the air films at the interior and exterior surfaces of the glass. The double-glazing (Figure III-1B) retains the benefit of the interior and exterior surface air films, and adds a very significant air space. Note that the extra thickness of glass has very little effect on the increased R-value of a double-glazed window. Window manufacturers have achieved U-values even lower than 0.58 by utilizing special surface treatments on the inner glass surfaces.

Outer glass surfaces can be coated with a material that reduces the solar heat transmission coefficient. This modification is not selective control of sunlight; it effects a reduction of sunlight admitted into the building at all times. While this product may not be applicable to many locations in the U.S., in warm climates, where cooling is required most of the year, it provides significant savings.

b. Insulation of Walls, Roof and Floors. Insulating the walls, roof, and floor of a building is the most basic energy conservation measure that can be taken. It is cited as one of the first steps to take in almost every reference that deals with ways to save energy in buildings. The installation of an average thickness of insulation in the walls, roof, and floor of a house can cause a reduction in the energy required for heating and cooling the house by about 50 percent from the energy prior to insulation.

A. SINGLE GLAZING

R-Value

Inside Film	0.67
Glass	0.04
Outside Film	0.17
Total	0.88

$$U = \frac{1}{R} = \frac{1}{0.88} = 1.13$$

B. DOUBLE GLAZING

R-Value

Inside Film	0.67
Glass 1	0.04
Air Space	0.8
Glass 2	0.04
Outside Film	0.17
Total	1.72

$$U = \frac{1}{R} = \frac{1}{1.72} = 0.58$$

Figure III-1. Window Components Which Contribute to the Resistance of Heat Flow

Several types of insulation are used today, including batts, blankets, loose fill, foamed-in-place, and rigid boards. Each type has its advantages and disadvantages, and the same thickness of each type of insulation will not necessarily provide the same insulating value. In order to provide a basis for comparison between different materials, an R-value (or heat flow resistance) for a specified insulation thickness can be determined.

Perhaps as important as the insulation itself is the manner in which it is installed. If insulation is cut too short so that it does not extend the full width and height of the space it was intended to fill, then heat will leak out around the edges of the insulation. Care must be taken when installing insulation in attic floors so that the ventilation of the attic is not blocked. (Ventilation is required to remove moisture which would otherwise condense in the insulating material, lowering its R-value). Small spaces around windows and doors must be filled with insulation or heat will leak out through those spaces. Vapor barriers must be installed properly or moisture will condense in the insulation and lower its efficiency. Installing insulation properly is not difficult, and it can greatly improve the performance of any insulating material.

c. Caulking and Weather Stripping. Air infiltrates into a building through any opening or crack in the envelope, (such as those around window and door frames), whenever the pressure outside the structure is greater than the pressure inside. The amount of infiltration is a function of the pressure difference (which in turn is a function of the wind speed) and the size of the crack or opening. Therefore, filling cracks with caulking and installing weather stripping to reduce the crack size around windows and doors will decrease infiltration.

Tests have shown that the use of properly installed weather stripping can reduce the infiltration through the cracks between a window sash and frame by as much as 80 percent (Ref. 28). To achieve such results, the weather stripping must be of reasonably good quality material, it must be cut accurately to the size of the window, and it must be carefully installed to insure that no gaps are left when the window is closed.

Caulking cracks will also reduce air infiltration. The most common places cracks occur are:

- around window and door frames,
- at corners formed by siding,
- at the foundation sill,
- where pipes or wires penetrate a wall or floor between a heated and unheated space,
- where two different materials meet (such as masonry meeting siding), and
- where the ventilators, mail slots, or other penetrations of the exterior wall are located.

d. Other Building Components. This category includes all other building components not summarized above.

Vestibule doors are another product designed to reduce infiltration. Although fairly costly to install as a retrofit item, vestibule doors can be added during construction at a moderate extra cost. They can result in up to five percent reduction in heating and cooling energy use (Refs. 2 and 3).

Masonry sealants both lock out subterranean moisture and increase the thermal integrity of masonry walls. Most sealants are paint-on and relatively inexpensive. They result in energy savings of one to three percent.

3. Major Appliances

Major appliances include all significant energy using equipment in the home that is typically purchased by the homeowner. This category of products used 19 percent of the national residential energy total in 1970. In the future, as improved building components reduce the energy requirements in buildings, and more efficient HVAC systems are employed to meet those requirements, appliance energy use will become an even more important part of the residential sector's energy picture. The major appliances surveyed include:

- water heaters,
- freezers and refrigerators,
- clothes washers and dryers,
- dishwashers,
- kitchen ranges and ovens, and
- monochrome and color televisions.

Each will be briefly discussed along with its energy savings potential.

a. Water Heaters. To fully understand both the existing and the potential energy saving improvements to water heaters, it is important to be familiar with their design features. The following quote from Consumers Report, March 1976, explains these features.

"A water heater...is a big container (the holding tank) with a source of heat. The tank is usually lined with vitreous enamel (or 'glass') to prevent corrosion. The gas models have a burner under the tank and an exhaust stack that runs up through the tank. The stack has two functions. It transfers some heat to the water and at the same time vents the burner. The electric units have two immersion coils - one at the top of the tank and one at the bottom. (Although the coils could be wired to operate simultaneously, utility companies in many areas allow only one coil to be used at a time. Electric units are wired so that the top heating element comes on after a large water draw, in order to heat a little water at the top of the tank quickly for the next use. When the top water is heated, that element switches off and the bottom one comes on to heat the rest of the water.) The gas heaters have a pilot and a safety switch to shut off the gas should the pilot accidentally go out. Both gas and electric models are controlled by thermostats that turn heat on and off, keeping the water at a preset temperature.

The heaters are all similar in shape: most are up-right cylinders, about 4-1/2 to 5-1/2 feet tall. Most of the electrics are for 240 volts and are rated at 4500 watts, the gas units at around 40,000-50,000 British thermal units per hour (Btu/hr)."

In general, oil fueled water heaters use the same type of tanks as gas water heaters. Some tanks are the center flue type; however, most oil-fueled water heaters use the floater type tank. This type uses the hot combustion products to heat the tank from the outside by passing between the tank and the outer casing, and then venting out the top or the side.

The floater-type tank is popular with oil-fueled heaters for two reasons. Firstly, a larger surface area is used for heat transfer than in the center flue type; and secondly, the oil heaters have high burner fuel consumption rates.* Oil-fueled heaters are not capable of lower firing rates because the orifice which controls fuel flow would have to be extremely small, and thus cause clogging. Because of higher firing rates, oil-fueled heaters typically do not have greater than 30 gallon tank capacities. Gas water heater tank capacities generally vary from 30 to 50 gallons with 40 gallons being the most common size. Electric water heaters vary from 40 to 80 gallons with 50 and 66 gallon sizes being the most popular.

Oil and gas burners require pilot lights to ignite the burner when heat is required. These pilots are typically small flames burning the heating fuel. A safety control is provided which shuts off the fuel supply in the event of pilot failure. Several other automatic controls are typically provided on commercially available water heaters including temperature control, water pressure control, high temperature limit control (on electrical units), draft control, and corrosion control.

Most gas and oil water heaters currently manufactured operate at an average service efficiency of approximately 45-50 percent and electric water heaters at approximately 75 percent (Ref. 27). These efficiencies are based on the use of 450 gallons of hot water per week and a 90°F temperature rise. Several modifications are possible to these current models to increase their efficiencies. These modifications are briefly discussed below.

In an attempt to provide high heat recovery rates - necessary to assure continuous hot water - gas water heater burner input rates have been pushed up to the maximum practical limit. Higher burner fuel inputs require greater cross-sectional flue diameters with accompanying greater uninsulated metal flue surface areas. This uninsulated flue surface causes greater standby heat losses. Therefore, reduced burner input allows for a smaller diameter flue with less uninsulated surface area and associated standby losses. It should be noted that gas water heaters can not be insulated to the point that the pilot light will over-heat the water, causing safety problems.

* Oil-fueled input begins at 70,000 Btu per hour and gas-fueled input does not exceed 75,000 Btu per hour.

According to an A.D. Little report, between 12 and 15 percent of total energy use in both fossil fuel and electric water heaters is attributable to losses through the container insulation. This leaves obvious room for improvement. These figures are based on current nominal insulation thicknesses of 1" (3/4" actual) for fossil fuel and 2" for electric heaters. The typical insulation material is a fiberglass blanket. By either adding a retrofit insulation jacket or designing thicker (3" for gas heaters) insulation, the energy use by water heaters could be reduced from 8 to 20 percent.

Standby losses - which account for about 25 percent of total energy use for fossil fuel burning heaters - can be divided evenly between jacket losses (discussed above) and flue losses. The flue loss during standby can be eliminated by using a flue damper to close the flue while the burner is off. If the flue damper were used with a constant burning pilot, a completely closing flue damper would not be possible, as some opening would be required to vent the pilot combustion products. The alternative to fully realize the potential energy savings is a completely closing flue damper with electric ignition of the main burner or electric ignition of a pilot burner which operates only during main burner operation. The expected energy savings with gas water heaters equipped with a flue damper and electric ignition has been computed by A.D. Little to be 13 percent. This energy savings corresponds to a potential efficiency improvement of 15 percent.

An alternate method of eliminating standby losses is to eliminate the holding tank and use a highly efficient electric heater to heat water when it is demanded as it flows through a very small tank. Such heaters are currently available at lower costs than the conventional design, and can result in a 98 percent efficient use of water heating energy. The principal drawback to this system is that large demands might not be met - but this is also a problem in holding tank heaters as well.

Currently used burners on oil fueled water heaters are powered; that is, they use air supplied by a fan for combustion. Gas water heaters use atmospheric type burners which rely on the Bernoulli principle for premixing of the air and fuel. These low pressure natural gas burners are limited by the amount of air which can be premixed to approximately 50 percent of the total stoichiometric amount of air required for combustion. The balance of air is supplied as

secondary air around the flame. In order to achieve complete combustion, approximately 50 percent excess air as secondary air (not premixed) is needed. This excess air is more than would be required by using a forced air supply with all premixed air and fuel. Excess air is heated by the flame thereby reducing flame temperature; therefore, a lower temperature difference exists and less heat is transferred to the water. Also more heat is lost out the flue than would be with a powered burner.

b. Refrigerators and Freezers. In 1970, about 8 percent of residential energy use is for refrigerators and freezers. This implies that increased efficiency in these appliances will result in significant national energy savings. A refrigerator or freezer is essentially an insulated cabinet, designed to store food at temperatures that will prevent its deterioration. The system used to maintain the cold temperatures is called mechanical refrigeration - which is a heat transfer system that removes heat from the interior of the enclosure and transfers it to the surrounding area.

The efficiency of the appliance is lowered by the conductance of heat to the inside of the enclosure through the walls and door, convective heat gain around the door; and is related to the efficiency of the sealed refrigerant system in removing heat. The efficiency of the system depends basically on the efficiency of its three major components (compressor, condenser, and evaporator) and the balance between them. Other factors such as defrosting systems, anti-sweat devices, ice makers, and other convenience features also affect the unit's energy consumption.

Possible energy improvements for refrigerators and freezers include an improved refrigerant; improved compressors, evaporators, and condensers; improved cabinet insulation door seals; and an anti-sweat defeat switch for dry climates and seasons.

c. Clothes Washers and Dryers. Clothes washers themselves consume less than three percent of the energy required to heat the water that they use to wash clothes. The energy savings potential for the washers themselves (exclusive of their hot water requirement) is negligible, but since clothes washers account for up to 30 percent of the hot water used in the household, more efficient use of the water would significantly reduce national energy use.

The most obvious way to reduce the hot water requirement for clothes washers is to reduce the temperature of the input water. According to laboratory tests conducted by General Electric, cleaning ability only slightly increases as the water temperature is increased above 80°F. Since most current washers use direct input of hot water (at temperatures ranging from 120° to 150°F), a substantial reduction in hot water use is possible with little loss of cleaning power. Better control of hot water use would reduce energy consumption by up to 50 percent.

Clothes dryers consist of an electrically powered revolving drum, and either an electric or gas heater. The gas fired dryers may have pilot lights that use over 5000 cubic feet of gas per year. These can be replaced with electric ignition devices. The cabinet insulation can be increased, resulting in a minor efficiency improvement.

d. Dishwashers. A major reduction in electric energy used by a dishwasher can be realized by eliminating the hot drying cycle presently used in most machines. This drying action accounts for about 40 percent of the electrical energy used by the dishwasher, and 18 percent of the total energy (including hot water) the appliance uses. The major constraint to this improvement is that it decreases the service provided by the machine, and will be met with some consumer resistance.

Dishwashers require very hot (150°F) water to properly operate with the currently available detergents - no other appliance in the home requires this hot water. Therefore, in order to meet the demand placed on it by the dishwasher, the hot water heater must maintain a higher water temperature than otherwise required, thus increasing standby losses considerably. If a booster heater is provided on the dishwasher, hot water energy use will be significantly reduced.

Other lesser improvements can be realized by reduced rinse cycles, reduced heater use for wash and rinse, and improved geometry and controls. These modifications can be incorporated into the presently available machines without decreasing their performance.

e. Kitchen Ranges and Ovens. In 1970, five percent of the energy used in the residential sector was for cooking. Although this is a fairly small figure, significant increases in the efficiencies of cooking equipment could result in substantial energy savings.

The product group containing electric and gas ranges includes a wide variety of products. Ranges are usually considered to be floor-supported units having a number of surface cooking units and one or more ovens. Ranges can also be built-ins, intended to be mounted in other structures. In addition, separate surface cooking units and separate ovens and oven combinations are manufactured for independent mounting on corners and walls. These various components can include as features other cooking devices such as grills, griddles, broilers, rotisseries, deep fryers, warmers, etc. Microwave ovens are also available as independent units, as components of ranges, and in combination ovens in which either normal (electric resistance) cooking or microwave cooking can be done.

Modifications to improve efficiency in these units include elimination of the pilot light in gas models, forced convection ovens, improved oven insulation, and increased use of microwave techniques. The major problem with these improvements is that they increase the price of the product.

f. Monochrome and Color Televisions. The recent move in the television industry towards extensive use of integrated circuits (or "solid state") has significantly reduced the energy use of both monochrome and color televisions. This change has drastically reduced the power consumption of the instant-on feature, since only the heater element in the picture tube must be kept hot (requiring only four to six watts).

B. Certification and Listing Agencies

There exists in the marketplace a multitude of products which may be installed or utilized in residential buildings. In the preceding section many of the energy use-related products which may be utilized in residences were identified. The consumers of these products (generally speaking) lack the necessary knowledge to evaluate whether or not these products will perform the function for which they are intended. Further, the consumer has little assurance that these products when utilized under a variety of conditions will not cause hazards, loss of property, or loss of life.

In the first part of this century many new and innovative products were being developed without any type of regulation. Many times these products were of shoddy construction and resulted in fires, damage, and a multitude of home casualties and deaths. Insurance companies found themselves liable for the casualties and property damages caused by improper installation of products utilized in the home, and consumers found themselves virtually unprotected from poorly developed or faulty products. Insurance companies originally provided the impetus for supporting garage-like testing laboratories to test products to evaluate their quality for consumer usage. Thus, the private sector began a self-regulatory process which identified, for consumers, products which had been tested for their intended use (within various acceptable standards) to assure at least a limited degree of safety. These garage-like laboratories gained support from tradespeople and other concerned manufacturers wanting to assure consumers that their products were safe and reliable.

Those small laboratories have grown into large recognized agencies. The enormous surge of new technologies (since the beginning of this century) spurred institutional specialization within these self-regulatory agencies. For example, Underwriters Laboratories (a nationally recognized certifying laboratory) is predominately noted for its success in testing electrical equipment and appliances used in the home. These agencies have promoted a voluntary process for manufacturers. Also, product testing is sales motivated. A manufacturer who wants to certify that his product is safe and reliable within limits (set by a specialized standards institution or specialized certification or listing testing laboratories) will submit his product to a recognized testing laboratory. The laboratory will test the product to see if it meets nationally recognized standards. After the product has been subjected to rigorous testing and is found to have met the nationally recognized standards, the testing laboratory will allow its symbol to be affixed to the product, thereby certifying it as a safe and reliable product for its intended use. These agencies have served the American public for over eighty years by promoting safe and reliable products and developing uniform testing standards.

In this section a presentation will be made which identifies some of the nationally recognized certification and listing agencies and standards making bodies are particularly pertinent to this study. Three categories of agencies have been delineated:

- (1) private sector standards-making agencies,
- (2) private sector certification or listing testing laboratories, and
- (3) governmental listing and standards-making agencies.

1. Private Sector Standards-Making Agencies

These agencies are involved in developing standards for private industry, specialized trade associations, and national consumer interests. For this study, some of the emphasis will be on those national consensus standards developed to protect the consumer and other interests. The following are some of the major standards development agencies:

- (1) American National Standards Institute;
- (2) American Society for Heating, Refrigerating, and Air-conditioning Engineers;
- (3) American Society for Mechanical Engineers;
- (4) American Society for Testing Materials; and
- (5) National Fire Protection Association.

The following provides brief discussions which further identifies the manner in which each affects the certification or listing process.

a. American National Standards Institute. The American National Standards Institute (ANSI) develops, maintains, and coordinates all procedures relating to the "preparation, approval, acceptance and designation of standards, and the constitution of standards boards and committees" (Ref. 1). ANSI does not develop standards, but only tests standards for general consensus. This private non-profit institution raises revenues by charging for the nationalization of a standard, as well as collecting fees from members (companies, organizations, government, and other interested bodies) (Ref. 2) comprised of over 160 technical, professional, and trade associations, and has support from more than 1000 company members (Ref. 3). Further, ANSI actively participates and is a member of the International Organization of Standards (IOS).

In the performance of ANSI's designated function of approving standards, it also provides a mechanism for standards development. A proposed standard (which may originate in a specialized committee) is exposed to a 60-day public review period by publishing a notice in ANSI's bi-weekly publication, "Standards Action." During this time period, those standards relevant to consumer products are also reviewed by the Standards Screening and Review Committee of ANSI's Consumer Council. If no problems arise, the proposed standard, in order to become a consensus standard, will be reviewed by the ANSI Board of Standards Review (BSR). This board will make the final decision to accept or reject a standard. A manufacturer who believes that the board's decision was unjust has fifteen days to register an appeal to the BSR. If the manufacturer remains dissatisfied, he may take his appeal to the Board of Directors of ANSI. All approved standards are then listed in ANSI's publication of standards which may be obtained (free of charge) from ANSI.

b. American Society of Heating, Refrigerating, and Air-conditioning Engineers. The American Society of Heating, Refrigerating, and Air-conditioning Engineers (ASHRAE) has been involved in standards development for heating, ventilating, and air-conditioning equipment used in residences as well as other product categories. Many of these standards have been adopted by national standards organizations. This institution does not directly engage in certification practices, although ASHRAE provides a listing of those products which meet ASHRAE standards.

The process by which a standard is issued begins when a need is recognized for a standard. First, a proposal for the standard is submitted by an interested party. For example, if a certifying institute requires a standard to initiate test procedures, a request or a formal proposal may be issued. A complex structure of funding regulations will define how the standard will be financed. It is projected that it takes between one to three years to get a standard developed. Acceptable standards will be published for public inspection in ASHRAE's Journals. If no objections are filed, the standard becomes adopted as a general consensus standard (Ref. 5).

ASHRAE, like other standards-making bodies, has engaged in developing performance standards. These standards emphasize the energy conservation performance concept, which incorporates energy design objectives and requires an approach to design without making unduly restrictive constraints on design options; e.g. ASHRAE Standard 90-75 (Ref. 4).

c. American Society of Mechanical Engineers. "The American Society of Mechanical Engineers (ASME) does not 'approve,' 'certify,' 'endorse,' or 'rate' any product or construction, and there shall be no statements or inferences which might so indicate" (Ref. 6). Further, ASME explicitly states to manufacturers that it is the manufacturer's responsibility to produce evidence of proper testing and inspection prior to coming to ASME. Also, a lack of knowledge on the part of the manufacturer cannot credibly be used as an excuse for failure to comply with ASME standards.

ASME is a standards-making body for a multitude of mechanical engineering disciplines. Their code development activities incorporate technical categories that range from space engine power machinery to underwater technologies. ASME's role is precisely stated as providing labels to products that have met ASME specifications.

"A manufacturer holding a code symbol and Certificate of Authorization from ASME, may state in advertizing literature that its products are built in accordance with the requirements of the ASME codes and have been tested by a laboratory authorized by the ASME..." (Ref. 6).

At least 3500 members serve on more than 400 ASME technical committees (Ref. 1). ASME codes are developed by technical committees comprising state and insurance inspectors, manufacturers, consulting engineers, and purchasers of mechanical products (Ref. 7). ASME claims that the members who serve on committees act independently of their corporate interests. Yet, major manufacturing companies are heavily represented on most of the technical committees by virtue of the fact that companies encourage their engineers to seek membership on ASME committees and also pay the membership dues for their employees. Actions such as these reduce the degree of individual independence maintained by members from particular corporate interests. ASME reports that 35 percent of its income comes from annual dues (Ref. 3). These dues provided in part by companies provide significant contribution toward maintaining ASME as a standards-making body.

d. American Society for Testing Materials (ASTM).

The American Society for Testing Materials is the dominant source of voluntary consensus standards for materials, products, systems, and services in the United States and perhaps, the world. ASTM is a non-profit corporation, formed in 1898, and has provided more than 5600 standards under copyright (Ref. 1). Approximately 7500 subcommittees support 128 technical committees, which emphasize the development of performance standards in such varied areas as steel, plastics, textiles, sports equipment, consumer product safety, security systems and equipment, etc. (Ref. 8). The standards developed incorporate test methods, definitions, recommended practices, classifications and specifications for product and product testing. ASTM's income is derived from the sale of standards and other publications (85%) and through administrative fees (15%) (Ref. 8). This organization is not subsidized by government or industry, and has a supporting membership of approximately 26,000 individuals including some 3000 international members (Ref. 8).

Consensus standards development, within ASTM, is based on a pluralistic philosophy. Every person participating on the standards committees visibly represent their personal or corporate biases (Ref. 10).

"ASTM Standards Committee is not a group of unbiased experts writing standards in a world untouched by commercial interest; it is rather a group of people with distinct biases-toward the manufacturer, toward the user, toward government, toward industry" (Ref. 9).

Twenty-six ASTM Districts cover the continental United States, plus one each in Hawaii and Mexico, which promote this concept of voluntary consensus standardization. In support of the consensus process, ASTM attempts to adhere to the principles of due process, assuring equal access to and equal voice in standards committees, and rejects discriminatory and anti-competitive effects (Ref. 9).

e. National Fire Protection Association (NFPA). The National Fire Protection Association's primary role is to develop national fire codes and standards. NFPA's 122 standards-making committees comprising over 27,000 individuals representing qualified international, national, and regional organizations have written and approved over 200 fire-related standards (Ref. 1). Generally, a fire standard (which is not specified by product or product category) is issued in recognition of a need for a standard as exhibited

by requests from manufacturers, builders/developers, and others. The Standards Council of the NFPA reviews those requests and then a NFPA committee determines if it is possible to develop a standard. A specialized standards development committee is comprised of experienced interested parties (whose members voluntarily participate on these committees) to evaluate proposed standards. If a standard is developed, it is then listed as a National Fire Code. In some cases National Fire Codes have been known to be mandated by local governments and adopted by Federal Government agencies and other standards-making bodies (Ref. 11).

2. Private Sector Certification or Listing Testing Laboratories

In this section two predominant independent testing laboratories will be discussed. These two agencies, Underwriters Laboratories, Inc., and the American Gas Association, are representative of many independent certifying or listing agencies. It has been noted that these two organizations maintain national and international recognition. Due to the pervasive recognition and the dominant role each plays as a leading certifying or listing institution in this country, both have been included in this survey of agencies.

a. Underwriters Laboratories (UL). Underwriters Laboratories Inc., is a not-for-profit organization engaged in standards development and in the testing of various devices and construction materials in order to protect consumers from loss of life, casualty, or loss of property (Ref. 13). Since 1894, Underwriters Laboratories has been noted for its role in the prevention of electrical and fire hazards in the home, although its charter is much broader. Underwriters Laboratories has issued more than 250 standards developed by various technical committees and supported by specialized subcommittees (Ref. 1). UL standards represent the sound engineering principles derived from consultant assistance and information obtained from manufacturers, users, inspection authorities, and others having specialized knowledge. Although, all products complying with these standards will not necessarily be eligible for listings, "if it is found that a product has other features which impair the results contemplated by these requirements" (Ref. 12). Also, UL provides tests to certify that products adhere to specified performance of UL standards. Test procedures include inspections and follow-up visits to those factories where listed devices are manufactured (Ref. 13). This action assures proper quality control and product development. It has been estimated that UL delivers over 1,000,000,000 labels annually to manufacturers who subscribe to the label

service (Ref. 1). UL funding depends to a significant degree on the number of products voluntarily submitted for testing. Due to this fact, charges have been lodged that UL writes standards that maximize revenues, rather than protect consumer well-being (Ref. 3).

UL remains a recognized bastion of consumer interests and its standards have been adopted by both national, and in some cases, international organizations.

b. American Gas Association (AGA). The American Gas Association is a non-profit organization which approves or certifies that products tested by AGA Laboratories comply in detail with all recognized national standards. It is estimated that some 150 million Americans utilize gas equipment and appliances in their homes (Ref. 15). The American Gas Association certification program utilizes equipment standards which are developed by the American National Standards Committees (for which AGA is the secretariat). The American National Standards Institute coordinates approximately 180 voluntary standards organizations and establishes the procedures to develop standards. Several methods are available to develop consensus standards: the canvass method, existing standards method, and the standards committee method. The AGA has selected the standards committee method for the purpose of drawing together a multitude of specialized interests to evaluate standards and to discuss and develop standards to insure product safety, reliability, and durability. The AGA approves and lists only those products which can demonstrate safety and durability by virtue of the fact that they have met nationally recognized standards.

The AGA's Laboratory certification program tests gas equipment, and reviews manufacturing procedures for manufacturing a product. All products tested by AGA Laboratories follow a similar set of steps for certification and these are:

- (1) product submittal,
- (2) testing Department's evaluation of product data and selection of applicable nationally recognized standards,
- (3) product testing,
- (4) review of test data,
- (5) listing of model number on the "Directory of Certified Appliances and Accessories," and
- (6) follow-up inspections.

Also, any manufacturer which feels that he has been unjustly treated by a laboratory may appeal to the Laboratories Managing Committee (a group of Senior Executives from AGA member companies are charged by the AGA Board of Directors with responsibility for Laboratory policy) (Ref. 15).

3. Governmental Listing and Standards Development Agencies

In the public sector, several agencies promote safe and reliable products for use in Federal Government buildings by listing or developing standards. Two of the more visible agencies, which have interacted with private sector standards development and certifying or listing agencies and have made considerable contributions to the practices and procedures of the certifying or listing process are the National Bureau of Standards (NBS) and the General Services Administration (GSA). The Bureau is primarily involved in assisting standards development for both the public and private sectors. The General Services Administration lists products which have met governmental standards. Many of the standards utilized by GSA have been adopted from the private sector. Other agencies such as the Department of Defense, specialized joint committees, and conference boards, perform similar functions in aiding standard development or listing of products.

a. General Services Administration. GSA is responsible for the procurement and supply of personal property and non-personnel services to government agencies. Also, GSA provides the management function of recording the disposal and utilization of U.S. property. In performance of these functions, they have become involved in the certification or listing process. The Office of Standards and Quality Control of the Federal Supply Service within GSA publishes a list of procurement items. The list, the Federal Supply Schedule, contains approved products, supplies and equipment generally bought by the U.S. Government. Further, the products on this list have been identified as meeting Federal standards. The standards that the Federal Government utilizes to evaluate products are identified in GSA's Federal Standardization Handbook. Included in this handbook are the statements of policies and procedures used for the development of product specifications and standards.

Due to the variation and massive amounts of supplies of equipment utilized by the Federal Government, a need for standardization of procured merchandise arises. Originally, the Federal Specification Board with seventy-seven

subsidiary technical committees attempted to develop standards for an ever growing number of products coming to the marketplace. In 1952, these committees were abolished due to the "need for increased speed and flexibility" in preparing new and revised specifications in order to keep ahead of the growth of new technology. Today, GSA utilizes the assigned agency method which relies on existing recognized agencies to develop standards. The recognized agencies referred to are private sector and public sector agencies that have traditionally written standards. Since the General Services Administration itself does not maintain expertise in all areas of product evaluation and standards development, it utilizes industrial and technical society standards as well as those developed by various Federal Government agencies to formulate the Federal standards by which products are tested and then listed (Ref. 16).

b. National Bureau of Standards. The National Bureau of Standards, a leader of standards development in the United States, has taken a reduced role in the voluntary standardization process. The need for extensive technical expertise as well as the fear of undue government regulation of private sector technological development has forced the Bureau into a passive role. However, the Bureau has over four-hundred employees still participating in private standards development committees (Ref. 3). Within the Bureau, the Center for Building Technology (CBT) is involved in standards development by providing the technical and scientific bases for criteria and standards that "improve the usefulness, safety, and economy of buildings while conserving building materials and energy" (Ref. 4). In performance of this role the CBT primarily provides assistance to standards development committees. Also, the CBT provides technical program management for advancing and developing energy conserving performance standards. In responding to ASHRAE 90-75, Energy Conservation in New Building Design (a conservation standard based on performance), the CBT will provide assistance to technical panels to update this series. Further, the Bureau will integrate other work completed in this area between various interested Federal Agencies. Also, the Bureau is developing energy standards models, which it is hoped will serve as a basis for coordinating a national system of standards. The Bureau's technical and professional services are now supporting the Energy Research and Development Administration, the Federal Energy Administration, the Department of Housing and Urban Development, and the General Services Administration in their overall energy performance standards development and technical program management. Other functions provided by the Bureau include: (1) providing the central basis for a complete and consistent system of physical measurements and (2) conducting material research and providing associated technical references.

By identifying these institutions, insights into the general process of certification or listing of products has been promulgated. In the following section, a brief presentation of the certification and listing process has been provided.

C. Certification Practices and Procedures

The certification and listing process provides for unknowledgeable consumers a 'stamp of approval' on products to indicate those products have been tested by certifying and listing organizations; have met recognized standards; and also are safe within limits for the purpose for which they were intended. There are two primary markets for which certification and listing of products are applicable: 1) the private sector commercial market and 2) the public sector Federal Procurement Market. In Figure III-2, both markets have been depicted as following a similar set of general procedures, in order to obtain certification or listing. The only difference in the two markets is the emphasis on standards development. In Figure III-2, an attempt was made to demonstrate that acceptable standards by which products are tested tend to flow from the private sector to the public sector. It is important to note that products submitted to either process are subjected to similar phases of certification and a product going through the processes may be restricted from certification or listing by not being accepted at any one stage. What this indicates is that each certification or listing phase was developed to provide cautious and careful assessments of products and to evaluate product safety and reliability for intended usage.

There are four primary phases associated with the certification and listing of products:

- Establishing Criteria;
- Standard Development, Testing Control;
- Certification and Listing; and
- Approval and Acceptance.

These four phases incorporate practices and procedures which are regularly conducted by most certifying or listing institutions. They are presented here in a generalized form in order to be inclusive for this analysis. In the following sections, the practices and procedures of the certification or listing process will be discussed as they relate to each respective phase. Let it be noted at the outset that these practices and procedures were designed to protect the public from unsafe or unhealthy products; to safeguard investments; and to protect the interests of insurance agencies,

Figure III-2 . The Certification or Listing Process

trade interests, interests of the manufacturing industry, and others, within a manageable and equitable framework.

1. Establishing Criteria

The first stage of the certification and listing process is perhaps one of the most crucial toward obtaining final certification or listing. The time expended to complete this first stage may range from three weeks to three years depending upon several factors, such as the number of applicants being reviewed, the type of product being submitted (i.e., new or innovative vs. existing products), the degree of completeness of the data submitted concerning a product, required payments for continuing the process, whether or not a standard exists to test the product, the manufacturer's responsiveness to returning of applications or providing additional information, etc.

Four significant stages are recognized as initial procedures and these are:

- Application for testing,
- Membership to the applicable standards-making organization,
- Evaluation of product design, and
- Selection of criteria by which to test a product and establish test methods.

A manufacturer voluntarily submits his product to the certification or listing process for a variety of reasons:

- A manufacturer may want to use a particular label as advertising;
- It may be required by a local code jurisdiction;
- Depending on its usage in the home, it may be required by various insurance agencies; or
- The manufacturer may be trying to obtain a commercial loan and the certification or listing will serve as evidence of a products potential marketability, etc.

The motivations for a manufacturer to seek certification generally arise from necessity attributable to demands by various institutions; otherwise, the manufacturer would present his product directly to the market.

The product to be certified is submitted through an application procedure. Once a manufacturer makes a request for certification, the certifying agency sends an application form accompanied by data sheets. These data sheets require specific information concerning the product. The manufacturer completes these forms, returns them to the institution, and then awaits the evaluation of the data. The certification or listing institution utilizes the manufacturer's data as a preliminary evaluation factor to determine product design or construction flaws. Also, if a manufacturer failed to provide all of the necessary information or additional information is needed, a request is made of the manufacturer at this time. This phase may be time consuming due to the amount of paperwork and correspondence required, although without this initial assessment, the selection of testing criteria cannot be made. For those products that have a history or are similar to other products that have previously been evaluated, the process is relatively efficient. But, for new products or products not carefully designed, the process becomes somewhat less efficient due to the need to develop new procedures or standards.

After a product has been accepted by the initial evaluators, selections of test and testing methods must be made. This step is entirely dependent upon whether or not an applicable standard exists in order to establish adequate test methods. If a standard does not exist, the product may still be tested, but not approved (as is the case with the flue gas damper - refer to the case study in Appendix D). The purpose of testing a product without a standard is that the information derived would be a useful aid in developing an appropriate standard. But these tests will cost the manufacturer additional time and money. To assist in standards development (assuming that a standard has not been developed), a manufacturer may voluntarily elect to become a member of the appropriate standards-making organization assigned to develop the standard. Membership on the committee developing a standard to test a particular product is not required, but it is to the manufacturer's advantage to protect his interests and to expedite the process by supplying immediate information to the standards development committee members.

2. Standards Development and Testing Control

In order to obtain certification or listing, test standards must be developed. In this section a brief discussion of standards development will be presented along with a discussion of the testing control phase of certification practices and procedures.

Standards development in the United States is a very complex process. Figure III-3 depicts standards development as occurring through a variety of mechanisms, none of which are standardized or routinely followed. A standard may develop in the public sector. For example, the Department of Defense may develop their own standards for equipment which they have developed. And the National Bureau of Standards through their work in material sciences and product development has initiated various standards. In the private sector, standards development begins with requests by various institutions.

The fact that new products are coming to the commercial market (which lack existing standards) points out the need for a standard. As discussed in Section B, there are standards making bodies chartered to develop specialized standards. Figure III-3 identifies some of these standards making institutions. The manner in which a standard is developed may vary depending on the institution which develops the standard. One attempt to organize the standards making process has been undertaken by the American National Standards Institute. This organization provides guidance to standards development for any institution. Also, it serves as a coordinating body for all standards being developed in the U.S. to reduce duplication of efforts.

Standards development is a voluntary institution which does not require adherence by any individual or corporate interest in the U.S. But, over the years, due to the lack of knowledge of technology, actions have been taken which, in some cases, make this process mandatory. For example, local government organizations have developed laws requiring a particular kind of certification or product standard in order to protect their citizens. Also, insurance groups have required specific types of certification for products used in the homes of their policy holders. In some cases, these actions can make a voluntary process involuntary.

The standards development process primarily works by a committee and subcommittee system. A product lacking a standard is introduced to a standards committee. This committee evaluates the particular expertise that is required to develop a standard. The product specifications are then sent to the appropriate specialized subcommittees which are delegated the responsibility for developing a standard to be utilized in product testing. Once this process is completed (which may take from 3 weeks to 5 years or more), testing criteria and test methods may then be developed. The product may advance to the next succeeding phase - product testing.

Figure III-3. U.S. Standards Development

Product tests are rigorous. They are conducted by experienced engineers. The tests on a product are limited by the state-of-the-art of certification and listing testing technology. The cost of testing will vary with the length of time that it takes to complete thorough investigations. Tests are not only rigorous, but in most cases rigid. A problem arises when a new or innovative product is not applicable to the standardized testing process. For example, a quartz space heater submitted to testing will be subjected to the same series of tests that are applicable to an electric coiled space heater. The problem is that the tests may not be applicable or the expertise to test this product may not be available. Finally, the results of the tests performed are presented to the manufacturer. The report includes information concerning construction features in compliance and those not in compliance with specified requirements. For those products not in compliance the manufacturer is required to make product alterations that are acceptable to testing officials. Once the changes are made, a report of acceptance completes the technical phases of product certification and listing.

3. Certification and Listing

In order to obtain product certification and listing, the product must be found technically sound and in compliance with recognized standards. A concluding requirement of this process is to negotiate follow-up procedures between the manufacturer and the certifying or listing agent. Follow-up procedures include visits to the manufacturer's facilities (many times unscheduled) to assure that the manufacturing process, facilities, and personnel are capable of producing like products to the model tested and accepted. Once these negotiations are completed, the appropriate label or listing is made available to the manufacturer. Labels are generally purchased from a certifying agent while listings may or may not include a minimal fee.

4. Approval and Acceptance

There exist two aspects to approval and acceptance which will be noted here. The first is that of the certifying or listing agent, as a part of the follow-up services, may revoke the certification of a product if the proper quality control is not maintained. Inspectors, who represent the certifying agency (who may be insurance agents, consulting engineers, laboratory personnel or some other party), conduct the inspections on the facilities. The cost of inspections vary but are generally recognized as the total expenses incurred by the inspector in performance of

his duties (who sometimes charge a designated fee). This is an ongoing service provided by certifying and listing laboratories which completes the formal certification or listing process.

Secondly, acceptance and approval may take other forms. The listings and labels promulgated by certifying or listing institutions must be acceptable to consumers of products. Consumers are primarily familiar with the major certification and listing laboratories and standards-making organizations. A label from a lesser known agency may not be found acceptable to consumers throughout the country. For example, a certifying agency that serves the City of Los Angeles may not be credibly acceptable in other regions of the country. Thus, the final approval process ultimately resides with the consumer and other institutional agencies that decide whether or not a product has received credible certification or listing.

Certification and listing practices and procedures are complex, although necessary to assure an unknowledgeable consumer that the products he buys (that are certified) will perform within designated safety limits and perform the tasks for which they were intended. From the survey of products, identification of certification or listing agencies, and designation of the practices and procedures associated with certification and listing process, it is plausible that some degree of marketing restrictions are attributable to product certification and listing. In succeeding chapters this relationship will be further analyzed.

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IV. IDENTIFICATION OF ENERGY CONSERVING PRODUCTS RESTRICTED BY CERTIFICATION AND LISTING PRACTICES AND PROCEDURES

An analysis has been conducted to identify those energy use-related products listed in Chapter III that have the potential for significant national energy use reduction and whose market penetration is inhibited by certification or listing practices and procedures. It is well known that many products utilized in residential buildings are restricted from market penetration due to certification practices and procedures. It is also known that, of those energy use-related products being restricted from the market, a percentage have energy conserving potential. By restricting energy conserving products from the market place, the nation's ability to meet its energy conservation goals is significantly reduced.

In performance of the stated objectives of this study, the list of products developed in Chapter III will be reduced to include only those products which have:

- potential for significant energy savings when utilized in residential buildings, and
- encountered restrictions from the market place due to the practices and procedures of the voluntary certification process.

Potential national energy savings will be determined for each product identified in Chapter III. Also, three significant factors related to certification and listing practices will be utilized to assess each product's market restriction. These factors include:

- time required to obtain certification,
- cost of certification, and
- availability of required consensus standards.

Every product will be screened by applying the above criteria and, for each product that exhibits both significant national energy savings potential and restricted market penetration due to certification, a detailed analysis will be conducted in Chapter VI to quantify the annual energy savings that would be realized by removing that product's certification barrier.

A. Product Screening Criteria

Two basic screening criteria must be applied to the energy-use-related products discussed in Chapter III to facilitate selection of those products relevant to this study. The screening criteria are:

- potential for significant national energy savings, and
- existence and significance of certification and listing barriers to the product's market penetration.

Potential for national energy savings must be greater than a predetermined level to assure that the product in question has a real possibility of contributing to national energy use reduction. This is not to say that this preliminary evaluation will calculate realistic conservation figures for each product. Obviously many exogenous factors influence the public's consumption of products, be they energy conserving or otherwise, and this consumption level in part determines the energy savings attributable to each product. Real market penetration projections will be determined only for those products that pass the initial screening. To summarize, the characteristic necessary for a product to pass the energy-related screening step is the potential for national energy savings of a certain significant magnitude.

This energy savings potential will be calculated in a two-step process. First, the average annual energy use reduction as a percentage of baseline product energy use has been identified for each product as part of the initial survey. These savings are shown in Table IV-1. Two facts should be noted concerning these "per unit" figures:

- they represent average national energy savings and may vary significantly in different regions and under particular conditions, and
- they are the percent reduction in baseline energy use by the product - or associated products*.

**For example, eight percent is cited for flue gas heat recovery devices in furnaces, which implies installation of such a device will result in only 92 percent as much fuel being consumed by the furnace. Storm windows are listed at 18 percent, which means their use will reduce total heating and cooling energy use in the house by that amount.*

TABLE IV-1. ENERGY USING PRODUCTS: SAVINGS

AND POSSIBLE BARRIERS
(CONTINUED ON NEXT PAGE)

PRODUCTS	SAVINGS PER UNIT (PERCENT)	POTENTIAL NATIONAL SAVINGS (PERCENT)	DURATION FOR CERTIFICATION (YEARS)	COST OF CERTIFICATION	EXISTING CONSENSUS STANDARDS
BUILDING SERVICES					
Furnace Improvements: more efficient heat transfer	6	3	0.25	\$1,200	Yes
flue gas heat recovery	8	4	?	?	No
better jacket insulation	*	*	-	-	Yes
flue damper	20	11	5.00	?	No*
electric ignition	15	8	0.25	\$ 200	Yes
open cycle combustion	8	4	0.25	\$1,200	Yes
better sizing	10	5	-	-	-
pulse combustion	30	16	0.25	\$1,200	Yes
emulsified fuels	20	11	-	-	-
Air Conditioner Improvements: component modifications	20	0.9	0.25	\$1,500	Yes
economizer cycle	10	0.5	0.33	\$1,500	Yes
Heat Pumps: replacing electric heat	30	16	0.25	\$2,000	Yes
heat only	50	27	4.00	?	No
Other System Components: recirculating kitchen fan	3	2	0.25	\$ 800	Yes
attic ventilation units	7	?	-	-	-
STRUCTURAL AND ARCHITECTURAL COMPONENTS					
Glass Products: storm windows	18	10	0.09	\$ 447	Yes
double glazing	10	6	0.09	\$ 447	Yes
reduced transmission glazing	8	5	0.09	\$ 447	Yes
Insulation: walls (R11)	15	9	0.25	\$ 215	Yes
floors (R19)	15	9	0.25	\$ 215	Yes
roof (R11)	25	15	0.25	\$ 215	Yes
Caulking and Weather Stripping:	8	5	0.25	\$ 400	Yes
Other Building Components: masonry sealants	2	1	0.083	\$ 350	Yes
vestibule doors	5	3	0.167	\$ 455	Yes

* no standard exists for retrofit units

TABLE IV-1. ENERGY USING PRODUCTS (CONTINUED)

PRODUCTS	SAVINGS ¹ PER UNIT (PERCENT)	POTENTIAL ² NATIONAL SAVINGS (PERCENT)	DURATION ³ FOR CERTIFICATION (YEARS)	COST ⁴ OF CERTIFICATION	EXISTING CONSENSUS STANDARDS
MAJOR APPLIANCES					
Hot Water Heaters:					
reduced burner rate and flue size	10	0.8	0.25	\$1,500	Yes
increased container in- sulation	15	2	0.25	\$1,500	No
flue damper and electric ignition	13	1.4	0.25	\$1,500	Yes
powered burner	*	*	-	-	-
instantaneous heater	23	1.5	0.25	\$1,500	No
Freezers and Refrigerators:					
improved refrigerant	4	0.3	0.25	\$ 900	Yes
improved compressors	28	2.2	0.25	\$ 900	Yes
improved evaporators	8	0.6	0.25	\$ 900	Yes
improved condensers	8	0.6	0.25	\$ 900	Yes
cabinet insulation	26	2	0.25	\$ 900	Yes
door seals	4	0.3	0.25	\$ 900	Yes
anti-sweat defeat switch	5	0.4	0.25	\$ 900	Yes
Infrared Space Heater	20	11	1.25	\$3,500	No
Clothes Washers:					
improved washer motor	*	*	0.25	\$1,500	Yes
better hot water control	20	0.9	0.25	\$1,500	Yes
Clothes Dryers:					
electric ignition	20	0.8	0.25	\$1,500	Yes
insulated cabinet	*	*	*	*	Yes
Dishwashers:					
water heater booster	13	1	0.25	\$1,500	Yes
reduced rinse cycle	7	0.5	0.25	\$1,500	Yes
reduced heater use	3	0.2	0.25	\$1,500	Yes
improved geometry and controls	10	0.7	0.25	\$1,500	Yes
Kitchen Ranges and Ovens:					
elimination of pilot light	30	1.5	0.25	\$1,500	Yes
forced convection	20	1	0.25	\$1,500	Yes
improved insulation	37	1	0.25	\$1,500	Yes
increased microwave use	20	1	0.25	\$1,500	Yes
Monochrome and Color Televisions:					
elimination of instant-on (solid state units)	*	*	0.50	\$5,500	Yes

*negligible savings

¹These are average figures and may vary significantly in specific cases. The figures reflect percent reduction in baseline energy use.

²These figures relate to reductions in total residential energy use.

³These are average minimum years it takes to obtain a first-time certification test, from application to facilities inspection.

⁴These are the average minimum costs to obtain a first-time certification test, from application to facilities inspection.

Secondly, these "per unit" figures will be used to calculate the maximum potential national energy savings on an annual basis. This process assumes 100 percent implementation of the conserving technology at current national saturation levels. The potential national savings are also listed in Table IV-1, and represent the product's maximum possible reduction of total residential energy use. This national figure will be used in the screening process to determine which technologies have significant conservation potential.

The second screening criterion is the existence and significance of certification and listing barriers to each product's market penetration. Only those products that have encountered (or are likely to encounter) barriers to marketing will pass this part of the screening. This restriction can occur in three ways:

- high costs incurred by the producer to obtain certification,
- excessive time associated with certification, and
- lack of a consensus standard for developing certification tests and testing procedures.

Cost of certification is, at first glance, a very ambiguous consideration. An excessive cost for a small volume producer of a low value product might be insignificant for a large manufacturing firm. However, if a product is to be produced in low volume, its associated national energy savings will be negligible, and would not pass the first screening step discussed above. For this reason, all costs are evaluated from the viewpoint of a large manufacturer. Table IV-1 gives average minimum costs for certification of each technology being screened. These figures were obtained by interviewing certification and listing agencies, as well as firms that presently are - or have in the past - engaged in obtaining certification for their products. It should be stressed that these are average minimum costs and may vary upward greatly in individual cases. In general, the more innovative a product is, the more expensive it will be to obtain certification and listing. The reason for this is simple: testing is more costly when new procedures and methods have to be developed. This also applies to complicated (versus simple) products. It should be noted that these minimum costs assume consensus standards exist, and will be much greater if, in fact, standards have to be developed. The costs are for first-time certification - recertification will be less expensive - and include all costs incurred between application and final facilities inspection by the certifying agency.

The time associated with obtaining certification is a real, easily accessible factor that has the same impact on all producers. More importantly, the time a conservation product is kept off the market due to lack of certification is associated directly with foregone energy savings. In an extreme case, certification may take so long that the producer will abandon the product, and its energy savings potential will never be realized. Certification times for each product are given in Table IV-1. These times were obtained by interviewing certification and listing agencies and firms with experience in obtaining certification, and represent minimum values. It should be noted that these minimum times assume a consensus standard exists for testing, and will be much greater if a standard has to be developed.

As the discussion above has implied, lack of a consensus standard is a major barrier to certification. The process for development, acceptance, and promulgation of a consensus standard is typically a long and expensive one. Both testing standards and procedures have to be developed before certification testing can begin. Lack of consensus standards is more of a problem with new and innovative technologies since they cannot be tested with existing standards and methods. This characteristic of the voluntary certification system has a double impact on new technologies: the product is kept off the market for a longer period of time than a less innovative product, and the producer is frequently a new (and therefore small) business enterprise that is more adversely affected by postponement of sales revenues than a larger, established firm would be. Several government agencies have been created to try and assist the small business in getting a start (mainly through counseling and financial help), but under the present standards system, little can be done to decrease the time barrier associated with promulgating a new consensus standard.

B. Screening Methodology

A consistent methodology must be used to select those products that meet both screening criteria discussed in Section A above. Only those products that:

- exhibit potential for significant national energy savings, and
- encounter significant certification barriers to market penetration

will pass the screening test.

Qualitative ratings of high, medium, and low have been assigned to each product to rate its savings potential, certification cost, and certification time. Existence or lack of consensus standards has also been indicated. The various ranges for each rating are:

	High	Medium	Low
Potential Energy Savings:	>5%	1%-5%	< 1%
Cost:	>\$1000	\$300-\$1000	< \$300
Time:	> 1 yr	0.5-1 yr	< 0.5 yr

A weighting system must be used to allow a qualitative assessment of the assigned ratings. The following weights have been assigned to each rating:

	High	Medium	Low	Yes	No
Potential Energy Savings:	2	1	0	-	-
Cost:	2	1	0	-	-
Time:	4	2	0	-	-
Existence of Standard:	-	-	-	0	8

These weights reflect the fact that lack of a standard is a very large barrier, a long time requirement for certification is the next important consideration, and costs (over the range exhibited by the survey) are the least significant barrier.

To couple the savings potential with the level of market penetration resistance due to certification barriers, the weighted ratings for barriers are summed and multiplied by the energy saving potential rating. It should be noted that zero has been used to numerically represent low ratings for each category. The effect of this is to require ratings of at least medium in both savings potential and at least one barrier category to result in a non-zero composite rating for the product. This is in conjunction with the initial screening requirement of both significant savings potential and existence of certification barriers for a "qualifying" product.

Table IV-2 lists each product, its numerical rating in each distinct category, and its composite rating - evaluated as described above. A composite rating of eight or more qualifies the product for detailed analysis. Those products that have passed the screening process are:

- flue gas dampers,
- flue gas heat recovery devices,

TABLE IV-2. ENERGY USING PRODUCTS BARRIER

ANALYSIS
(CONTINUED ON NEXT PAGE)

PRODUCTS	POTENTIAL SAVINGS RATING	CERTIFICATION TIME RATING	CERTIFICATION COST RATING	CONSENSUS STANDARD RATING	COMPOSITE RATING
<u>BUILDING SERVICES</u>					
Furnace Improvements					
more efficient heat transfer	1	0	2	0	2
flue gas heat recovery	1	-	-	1	3
boiler jacket insulation	0	-	-	0	0
flue damper	2	4	-	1*	24
electric ignition	2	0	0	0	0
open cycle combustion	1	0	2	0	2
better sizing	2	0	2	-	4
pulse combustion	2	0	2	0	4
emulsified fuels	2	0	2	-	4
Air Conditioner Improvements					
component modifications	0	0	2	0	0
economizer cycle	0	0	2	0	0
Heat Pumps					
replacing electric heat	2	0	2	0	4
heat only	2	4	-	3	24
Other System Components					
recirculating kitchen fan	1	0	1	0	1
attic ventilation units	2	-	-	-	-
<u>STRUCTURAL AND ARCHITECTURAL COMPONENTS</u>					
Glass Products					
storm windows	2	0	1	0	2
double glazing	2	0	1	0	2
reduced transmission glazing	1	0	1	0	1
Insulation					
walls (R11)	2	0	0	0	0
floors (R19)	2	0	0	0	0
roof (R11)	2	0	0	0	0
CaULKing and Weather Stripping	1	0	1	0	1
Other Building Components					
masonry sealants	1	0	1	0	1
vestibule doors	1	0	1	0	1

TABLE IV-2. ENERGY USING PRODUCTS BARRIER
ANALYSIS (CONTINUED)

PRODUCTS	POTENTIAL SAVINGS RATING	CERTIFICATION TIME RATING	CERTIFICATION COST RATING	CONSENSUS STANDARD RATING	COMPOSITE RATING
<u>MAJOR APPLIANCES</u>					
Hot Water Heaters					
reduced burner rate and flue size	0	0	2	0	0
increased container insulation	1	0	2	0	2
flue damper and electric ignition	1	0	2	0	2
powered burner	1	-	-	-	-
instantaneous heater	1	0	2	8	10
Freezers and Refrigerators					
improved refrigerant	0	0	1	0	0
improved compressors	1	0	1	0	1
improved evaporators	0	0	1	0	0
improved condensers	0	0	1	0	0
cabinet insulation	1	0	1	0	1
door seals	0	0	1	0	0
anti-sweat defeat switch	0	0	1	0	0
Infrared Space Heater	2	4	2	8	28
Clothes Washers					
improved washer motor	0	0	2	0	0
better hot water control	0	0	2	0	0
Clothes Dryers					
electric ignition	0	0	2	0	0
insulated cabinet	0	0	2	0	0
Dishwashers					
water heater booster	0	0	2	0	0
reduced rinse cycle	0	0	2	0	0
reduced heater use	0	0	2	0	0
improved geometry and controls	0	0	2	0	0
Kitchen Ranges and Ovens					
elimination of pilot light	1	0	1	0	2
forced convection	1	0	2	0	2
improved insulation	1	0	2	0	2
increased microwave use	1	0	2	0	2
Monochrome and Color Televisions					
elimination of instant-on (solid state units)	0	2	2	0	0

- heat-only heat pumps,
- instantaneous hot water heaters, and
- infrared quartzite space heaters.

Another product, urethane insulation, is not on the list of products but is discussed (as a component of a building system) in the Appendices because of its unique history. Urethane insulation was kept off the construction market primarily due to code restrictions (building code enforcement officials) and finally its manufacturers were forced to alter the product (with the effect of reducing its insulating ability) to meet the existing fire standards. This product is an excellent example of how building code enforcement officials can make mandatory the conformance with voluntary standards.

V. IDENTIFICATION OF BARRIERS

The rate of market penetration of energy use-related products is affected by certification and listing practices and procedures. In this chapter, several significant market restrictions associated with the certification and listing process will be identified. In the previous chapter, market restrictions attributable to certification and listing were characterized by the amount of time and money associated with product certification. But time and money constraints are representative of other factors that affect the market penetration of energy use-related products. Six general categories of certification and listing features have been identified:

- General Institutional Features,
- Due Process Features,
- Testing,
- Standards Development,
- Economic Constraints, and
- Legal Constraints

Brief descriptions of each feature classification have been provided in Section A. Section B provides a more detailed discussion of the specific barriers identified within each major category.

A. System Feature Classification

Any identified barrier may be associated with a specific element of certification or listing practices and procedures. For example, several market constraints associated with the certification or listing process stem from conflicts between institutions. Additionally, the total process of certification has been identified as an area in which market penetration restrictions may occur. For those energy use-related products that enter the certification or listing process, there are two significant stages where restrictive procedures exist. These are: (1) developing testing criteria and (2) developing standards for certification. Further, the marketplace has traditionally identified safe and reliable products as those having been certified or listed. Various economic constraints

have resulted from lack of acceptance of products by financial groups. Finally, legal constraints arise due to the fact that certification and listing standards have been mandated by code requirements in various local, state, and federal governments.

1. General Institutional Features

Institutional barriers arise due to various institutional interests that interact in the certification and listing process. A major characteristic of the certifying process is that it operates on a consensus basis. Consensus is achieved through the give and take of conflicting opinions and ideas. In the certification and listing process, many institutions represent distinct concerns and interests.

Some of the major types of institutions that participate in the certification and listing process are listed below:

- (a) manufacturers,
- (b) certifying and listing agencies,
- (c) standards-making organizations,
- (d) finance groups,
- (e) governmental agencies, and
- (f) consumer groups.

2. Due Process Features

The certification and listing process consists of various stages. Each stage of certification or listing has associated requirements that must be adhered to in order for a product to continue through the process (refer to Figure III-2 on page III-31). At any one of these stages a product may be rejected. Various steps within this process have been identified as being unduly restrictive.

3. Testing

Testing is a significant step within the certification process. Some constraints may arise when the testing technology is not flexible enough to adequately test new products.

4. Standards Development

Standards must be developed when new products are introduced to certifying institutions and applicable standards do not exist. Market penetration of products is inhibited since the process of standards development requires a good deal of time. Also, conflicting interests that arise during standards development require additional time to be resolved.

5. Economic Constraints

Economic factors associated with certification and listing practices and procedures that constrain the market penetration of a product fall into two broad categories: resource availability and market response. Resource availability constrains the market penetration of energy use products when a manufacturer who needs loans or additional funding must prove to lending institutions that his product is highly marketable. A criterion used to determine marketability is certification. Without certification, a manufacturer has reduced his chances of obtaining a loan. The manufacturer also cannot afford to produce uncertified products because the market demands that products be certified.

6. Legal Constraints

The process of certification or listing of products is generally recognized as being voluntary and is designed to identify safe products for consumers. However, this voluntary certification can become required for successful product marketing. Many local building code officials lack the technical expertise to identify safe products for homeowners in their community. In order to insure that the public is protected, local code officials have supported the codifying of recognized voluntary standards developed by the major certification and listing institutions. Market penetration of newly developed and uncertified products is thus inhibited.

B. Discussion of Barriers

Specific barriers will be discussed for each of the six major categories identified in Section A. The barriers identified within this section affect to some degree the rate of market penetration of all products.

The barriers discussed below were identified by means of personal contacts with knowledgeable individuals, literature review, workshops held at Hittman Associates and Michigan Consolidated Gas Co., and case analysis of products identified as having encountered market restrictions related to certification or listing. A list of individuals contacted, literature review information, workshop summaries, and case studies are included in the Appendices.

Table V-1 relates barriers to the system features that cause them. It can be seen that a specific barrier may be caused by numerous features of the existing system. This fact should be kept in mind when attempting to remove the barriers by developing programs and altering the features.

1. General Institutional Constraints

Many institutions actively participate in the various aspects of the certification and listing process. The interests of the participants many times conflict due to the distinct nature of the institutions. Manufacturers, certification and listing institutions, financial institutions, standards-making organizations, government institutions, and consumer institutions have been identified as groups participating in the certification and listing process. Barriers that arise due to the special interests of each of these groups are discussed below.

a. Manufacturers. The barriers that are attributable to manufacturers result primarily from a lack of knowledge and/or experience concerning the certification and listing process, as well as from the advocacy role maintained by manufacturers.

(1) Lack of Knowledge. Many first-time manufacturers approach a certifying agency with a lack of knowledge of the specific requirements for various stages of the certifying process. Manufacturers' products may be rejected

TABLE V-1. SYSTEM FEATURES AND RESULTING BARRIERS

SYSTEM FEATURE	BARRIER					
	Lack of Information	Limited Number of Institutions	High Cost of Certification	Lack of Performance Standards	Liability Awareness	Long Time For Certification
General Institutional Constraints	X	X	X		X	X
Due Process Constraints	X		X		X	X
Testing Constraints			X			X
Standards Development			X	X		X
Economic Constraints		X				X
Legal Constraints		X			X	

at a number of stages because of incomplete product design, inadequate model development, and a general level of unpreparedness. Time is lost while the manufacturer develops the required information, delaying the products entry to the market.

(2) Advocacy Role of Manufacturers. A manufacturer must produce products that are reasonably safe, and must do so in a profit-maximizing manner by utilizing the least costly manufacturing techniques and materials available. Certifying or listing agencies provide testing to insure that these products are safe within specified limits. Points of conflict arise during the certifying process when a product does not meet testing requirements. For example, a technical flaw may exist in the product that was previously undetected by the manufacturer. At this point, negotiations between the manufacturer (who supports his product) and the certifier (who will not accept the product as it is) will take place in order to resolve the conflict. Most large manufacturers have designated staff members who interact with certifying agencies on a regular basis. But the first-time or small manufacturer lacks the staff and the time to conduct routine interaction with certifying and listing institutions. Limited time and money become key factors and restrict involvement for the small manufacturer.

b. Certifying or Listing and Standards Development Institutions. The impact that certifying or listing and standards-making institutions have on restricting the market penetration of a product is significant. These institutions are involved in the testing and evaluation of products as well as in the development of standards by which products are tested. Thus, some of the institutional restrictions created by certifying or listing agencies are similar to standards-making bodies. These barriers include the traditional figures of authority. The American Society of Mechanical Engineers, Underwriters Laboratories, American Society of Testing Materials, American Gas Association, Air-conditioning and Refrigeration Institute and others are familiar names to many homeowners or purchasers of major appliances, mechanical components, and structural and architectural materials. These authorities publicize that the products carrying their labels have met nationally acceptable standards. For the less informed consumer public, these standards-making and certifying and listing institutions have been viewed as the primary authorities of identifying safe and reliable products. Due to this deference to an authority, barriers arise to the manufacturer who must obtain certification or listing from these institutions in order to market his product.

c. Finance Groups. A manufacturer may have a product already developed and ready for the market but may need additional capital to commercialize the product. A key criteria used to judge the product's marketability is whether it has been approved by a nationally recognized certifying or listing agency. If the manufacturer cannot demonstrate that the product has met the standards of the appropriate agency, he may not receive funding. Thus, the market penetration of the product is once again restricted. If the term "Finance Group" is broadened to include insurance groups as well as lending institutions, another barrier to market penetration may result. Many insurance groups (some of which were major financial contributors to certifying agencies; hence the name Underwriters Laboratories) write home and commercial insurance policies which require use certified or listed products. A case in point supporting the above statement is the Michigan Consolidated Research Project. This project is an ongoing test program of devices that reduce gas consumption when installed on gas furnaces. These devices, for purposes of the research project, were retrofitted on homes in the Detroit area. Local code and insurance groups require that products used in Detroit homes be certified by the major certification institutions. Four of the five products being tested in that study did not meet Detroit's local codes and one was not certified. For the purpose of the study, Michigan Consolidated was allowed to retrofit test homes, but had to agree that they would restore the homes to their original condition upon completion of the test. (Ref. 8).

d. Government Institutions. Government institutions contribute to restricting the market penetration of products in both public and private sector markets. The Federal government provides a list of products to be used by other federal agencies, (i.e., the Federal Supply Schedule). Most of the products on this list are required to meet a variety of public sector standards. Thus, the constraints applicable to private sector certification and listing confront products used in the public sector markets. Also, the waning role of government institutions in the certifying process over the last decade has contributed to the development of constraints on market penetration.

(1) The Federal Government as a Lister Of Products. The Federal government's list of products maintained by the General Services Administration is noncompetitively displayed; therefore, the products documented are purchased more frequently than products not listed on the Federal Supply Schedule. In order for a product to be listed, it must be consistent with specified standards. Many of the standards utilized are adopted from major certifying agencies in the private sector. For example, it is not unlikely to encounter UL, ASTM, or AGA certification as a required government standard. Therefore, many of the same constraints attributable to the private sector are also applicable to the public sector. And a manufacturer who has experienced difficulty in one sector may be discouraged from the other sector because of an awareness that the same problems exist in both markets.

(2) Reduced Role For Government in the Private Sector. The Federal government has recently exhibited a laissez-faire policy with respect to the certification and listing process. Prior to 1960, its impact was significant; however, during the sixties, only three percent of all voluntary standards were written under the National Bureau of Standards procedures (Ref. 2). The purpose was to provide minimal supplemental assistance rather than to compete with private sector certifying or listing institutions. Due to this laissez-faire policy, producers of new products that are inconsistent with traditional standards and/or test procedures have lost an alternative mechanism for appeal. The present reluctance of government institutions to participate in this process has acted as a market restriction for products which are not acceptable to the private sector's rigid procedures.

e. Consumer Institutions. Consumer institutions are associated with certification or listing of products in two respects. The first has to do with consumer interest groups that actively participate in the standards development activities. The second involves the primary role of consumers - consumption of safe and reliable products.

(1) Lack of Technically Proficient Consumer Advocates on Standard Development Committees. The input from consumer advocates on standards-making committees is limited by their inability to technically evaluate products. Non-technical consumer representatives have a vote which may be used to veto the passage of a standard for new products seeking certification. The lack of technical proficiency of consumer representatives who serve on standards-making committees may inhibit market penetration of product in two ways:

(1) If the consumer group serving on a committee represents an alarmist institution; a standard may be restricted from being developed due to unsubstantiated fears of a suspected, but not proven, unsafe product.
(2) When the consumer representatives on the committee lack an awareness of whether or not particular standards in question are appropriate, they may be swayed by other group members' opinions to either accept or reject a standard.

(2) General Lack of Knowledge of Consumer Institutions. Some consumer magazines and organized representatives of consumer product evaluations emphasize quality products as those having obtained labels or listing from major certifiers. This action becomes a barrier for uncertified products, since consumers will tend to buy those products advertised as being certified.

2. Due Process Constraints

The certification and listing process itself is a barrier to the market penetration of energy use-related products. If the process did not exist, products would enter the market immediately. But, given that the certification and listing system remains, a restriction (due to market entrance time-lags) must result. Within this process, constraints associated with the due process of certification and listing practices and procedures are:

a. Membership. Membership for those who want products certified or listed is not required for most certifying or listing agencies. However, membership is usually required for manufacturers who wish to participate on standards-making committees. For manufacturers of new products lacking standards, it becomes advantageous to obtain membership in order to serve on the committee developing the standard used to test his product. By participating on the standards committee, a manufacturer could discuss and provide first hand knowledge of the new or innovative product. Also, other members on the committee may have had unfavorable experience with similar products and may be inherently biased against a standard being developed for this new product. Further, a product may prove to be in strong market competition with products produced by other manufacturers evaluating the product.

So, it is in the best interest of a manufacturer to become a member of a standards-making committee. But membership requires both time and money. For the manufacturer not having the available time and/or money to become a member of a standards-making committee, market restrictions may

arise because he is not available to protect his interests and/or provide immediate information needed to develop a proper standard for the purposes of product testing.

b. Selection Criteria for Testing and Testing Procedures. Selection criteria for testing new products can present a barrier to product penetration into the marketplace. The selection criteria is based upon the design specifications and product descriptions submitted by the manufacturer. Many first-time submitters of products may not have the expertise and knowledge to provide the necessary information for testing agencies. This information may be necessary for selection of proper testing criteria.

Further the criteria are selected by individuals who have technical expertise with a particular product class. These individuals, who are well qualified to select a test for a particular type of product, may not be able to select proper testing criteria for new or innovative technologies. For example, an individual who has selected testing criteria for an average electric space heater may not have the expertise to select adequate testing criteria for an infrared quartz space heater (Ref. 6). Thus, the improper selection of test criteria may restrict a product's ability to obtain certification, which will ultimately restrict the product's market penetration.

c. Backlogs Attributable to Due Process. Two primary causes of testing backlogs are: (1) certification repeaters, and (2) the limited number of recognized institutions available to test products. Products submitted to certifying agencies must wait in turn to be processed and then tested. One cause of testing backlog (other than the time it takes to complete tests) is the number of products that are returned to manufacturers for redesign, and then are returned to the testing agency for further testing. The process may take weeks, months, or years. Further, few certifying or testing institutions recognize priorities for products awaiting certification.

Backlogs are also caused by the need to obtain certification or listing of products from nationally recognized institutions. This factor is magnified by the limited number of nationally recognized certification or listing institutions. The inability of manufacturers to obtain speedy access to these few institutions becomes a key concern. The manufacturer may incur extensive costs and loss of valuable time if he has to wait excessive lengths of time to enter the process of certification.

d. Facilities Inspection. The final stage of the certifying process is a facilities inspection by a representative of the certifying agency to determine if the facility is adequate for producing products like the one certified. Two problems arise: (1) The manufacturing facility may not possess a staff qualified to maintain adequate quality control. Also the facility may not possess the proper product development equipment to assure quality control. (2) The inspector from the certifying agency may not be qualified to properly assess the ability of the facility to manufacture its product, or, alternatively, the inspector may be judging the manufacturer's ability to maintain quality control by using criteria that may not be appropriate for new or innovative product.

Other restrictions are related to "due process" of certification or listing. In the Appendices on page D-6, a case study of Janitrol's heat-only heat pump provides an example of the factors associated with certification and listing process restrictions on the market penetration of products.

3. Testing Constraints

Inadequate testing ability for new products may cause restrictions to the market for new and innovative energy-use-related products.

a. State-of-the-Art of Testing Equipment and Procedures. New products seeking certification or listing may be restricted from market penetration due to a paucity of methods or equipment to test new products.

b. Inflexibility to Evaluate New Materials and New Products. The procedures set for laboratory technicians are rigid. New energy use products of designs varying from those normally tested under a set of prescribed tests may experience certification or listing restrictions based on the inflexibility of tests and rigid safety criteria. The flue gas damper is a product for which standards-making institutions have been unable to develop testing or standards criteria to evaluate product safety. A case study of the product is presented in Appendix D.

4. Standard Development

As discussed earlier, the practices and procedures of certifying and listing agencies include the development of standards. Standards development activities may prevent some useful, innovative, economical, or energy saving device from reaching the market. Several of the major barriers attributable to standards development are discussed below.

a. Due Deliberation of Committees. Standard development in the U.S. primarily occurs through a committee system. A product lacking a standard and requiring certification is presented to the proper technical committee at some prearranged time. The committee members return to their respective institutions to evaluate, comment, and decide on whether or not a standard could be developed for the product. The committee will either reconvene or either develop an acceptable standard or to implicitly reject the product by not developing a standard. When the individuals on these committees properly analyze the product and doubts about a product's safety are abolished the meetings may progress efficiently. Individual committee members, who represent major institutions, have the ability to deliberately restrain the standard from being developed by refusing to act (Ref. 3). Many times there are no alternative routes for appeal for manufacturers if a standard is not developed by the appropriate certification or standards development body. In the case where a manufacturer feels unjustly or unduly restricted by a particular standards development committee, few if any alternatives are available. A case in point is the flue gas damper which has been appendixed. The time associated with due deliberations of committees directly impacts the ability for manufacturers to market products (refer to the Janitrol Case Study in the Appendices).

b. Balanced Committee and Subcommittee Representation-Unbalanced Input. It was previously stated that the committees are developed in a manner to accommodate consensus decisions. The committee system is made up of established manufacturers, tradespeople, and others who have an interest in the outcome of standards being developed. The actual input to these committees has been described as favoring the established technical interests represented on the committees. First-time producers are perceived as being transient to the committees, and consumer advocates on these committees usually lack the technical expertise to evaluate a variety of products. It is this unbalanced input on committees that may restrict the market penetration of products. The well established interests (primarily tradespeople and larger manufacturers) who have support the status quo and are hesitant to actively support new standards, thereby causing a restriction for new products on the basis of bias rather than technical failure or safety considerations.

c. Use of Prescriptive Standards. Prescriptive standards are being used to evaluate products coming to the marketplace. Prescriptive standards are expressed by specifications indicating how a product should operate and/or what the content of an item should be. Standards development in this manner is antithetical to the development of new and innovative products. A prescriptive standard does allow for predictable use of materials and the function a product is intended to be used, but prescriptive standards may restrict new products of varying design, which perform the same functions as conventional products, (possibly more efficiently) from coming to the market. (Refer to the Janitrol heat pump case).

5. Economic Constraints

Economics of product certification is a key concern for the manufacturer seeking certification or listing. The manufacturer's goal is to maintain solvency through product development and commercialization.

All manufacturers are limited by the amount of resources (materials, labor, and capital) to be spent in developing and commercializing a product and will want to minimize this expense. Certification and listing can be a major obstacle to market penetration of products due to the fact that excessive costs may be associated with this phase of development and commercialization. Below is a discussion as to the certification and listing system, features which primarily restrict the market penetration of products in two phases: (1) product development and (2) commercialization.

a. Product Development Constraints. A manufacturer will submit his product to the certification and listing process while the product is in the developmental stage to have the product certified or listed at the same time the production process is ready to commence. During the initial phase of certification and listing, the paperwork needed to describe the product and its functions is significant. The amount of paperwork necessary for new or innovative products (with no prior testing history) is more burdensome due to the fact that in order to develop proper testing criteria very detailed and concise information is demanded.

Another high cost area associated with product development is developing product test models. Many certifying and listing institutions require a number of test models to be evaluated. A test model is required for each product of slight variation in design or content. Also, for one model group, a large number of random samples may be requested by certifying and listing agencies for testing purposes.

b. Commercialization of Products. Many consumers and institutions require that products already developed obtain certification. A manufacturer who has a production process already developed may have to make costly alterations in the production process in order to obtain certification. This situation may result from: poor product designs developed by a manufacturer, the use of prescriptive standards in evaluating a product, or from any of the other systems features which may restrict market penetration. But no matter what the reason, if a product must be significantly altered in order to obtain product certification this may cause a costly change in the production process. This cost may be too great for a manufacturer to bear.

Further the nature of a product may cause excessive costs for certification. For example, for small specialized electrical units (e.g., transistors, electric ballasts, etc.) which are capital intensive and demand a high volume output, certification and listing of various models and designs may be costly. Manufacturers of such products need to seek access to a multitude of markets which may require various certifications and listings. In order to market such products, large amounts of capital are needed. To obtain loans for commercial purposes, investors must have some indication of a product's marketability. Marketability criteria may be determined by whether or not a product has obtained a certification or listing. Thus, in order to obtain a loan the product must have already been certified.

6. Legal Constraints.

a. Mandating Certification of Listing Standards. Many of the several thousand local code jurisdictions have mandated nationally recognized standards. Therefore, products not certified by a major certifying or listing agent will not by law be able to achieve maximum market penetration.

b. Few Appeal Mechanisms. In order to obtain certification or listing of a product, a manufacturer is bound to the limited number of recognized certifying or listing agents for validating his product. If an unresolvable conflict arises between the manufacturer and the certifying agent, the manufacturer has few alternative routes for appeal. In some cases the manufacturer must obtain certification from only one certifier. For example, a manufacturer of household electrical appliances will seek Underwriters Laboratories approval, a gas appliance manufacturer is primarily bound to AGA certification, air-conditioning equipment is certified by ARI, and for testing standards - ASTM standards are primarily followed for building materials.

In each instance, the manufacturer has limited alternative avenues to follow if he feels that he is unjustly treated. In the past, an avenue open to the manufacturer has been the Senate Judiciary Subcommittee on Antitrust and Monopolies. However, this avenue is limited by the possible number of individual cases that may be directly served by this committee. (Ref. 3). Of course, the courts are available to those manufacturers who want to go this route.

Any of the barriers identified above may restrict the market penetration of energy-use related products. In the following chapter, an analysis of market penetration will be performed for the screened products identified in Chapter IV. The analysis will identify a product's market penetration potential with and without certifying or listing restrictions. Included in the analysis will be the calculations of potential energy savings and the development of a priority listing of the most important system constraints discussed above.

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VI. PRODUCT ANALYSIS AND RANKING OF BARRIERS

The net energy savings due to the removal of certification and listing barriers for each product selected in Chapter IV have been calculated. A market penetration model has been used to determine the future sales volume for each product, with and without certification barriers. Input to this model included economic data, product availability, and other exogenous considerations. This analysis required the determination of unit energy savings and cost-effectiveness. A regional approach was used to analyze the four general housing types that comprise the residential sector: single-family, townhouse, low-rise and high-rise.

Both the penetration model and the energy analysis are described below. The net energy savings have been tabulated, barriers associated with those savings identified, and the barriers ranked in order of importance based on the increased energy conservation associated with their removal.

A. Market Penetration Model

The projection of a particular commercial product's market penetration - especially when little or no existing sales data is available - is very dependent on the class of customer expected to be the primary consumer of that product. The reason for this is very simple: different customer classes (homeowners, builders, tenants, etc.) have varying purchase decision criteria, and thus each class' level of consumption of a particular product will depend on a different emphasis of three basic considerations. These basic considerations include:

- cost considerations,
- product availability, and
- exogenous factors.

These considerations have been incorporated into an empirical model that projects an annual market penetration rate for each consumer class. This model projects decisions made by:

- homeowners,
- builders,
- landlords, and
- tenants

concerning a specified product, based on fifteen independent parameter evaluations, including:

- cost effectiveness,
- initial cost,
- payback period,
- product availability,
- fuel price expectations,
- installation inconvenience,
- rental price inelasticity, etc.

This annual market penetration rate, which is expressed as a percentage, is calculated on a regional basis for those products that have a cost-effectiveness that is affected by climatic variation. These rates are then applied to the potential markets to determine the number of products bought each year. For each successive year after the first, the potential market must be readjusted to reflect to previous years sales as well as natural growth in the market.

B. Baseline Energy Use Development

The energy use rates of certain selected products, especially those dealing with space conditioning, are highly dependent on the prevailing climatic conditions. For this reason, a regional approach has been utilized in analyzing several of the product categories, including heat pumps, infrared space heaters, flue gas dampers, heat recovery devices, and urethane insulation; the instantaneous water heaters were analyzed on a national levels since use rates were much more dependent on other, non-climatic factors which were regionally invariant.

1. Regional Approach

To facilitate a regional analysis, the country was divided into five sections (as illustrated in Figure VI-1), according to climate. In order to more easily quantify the energy use patterns for each region, a representative city was assigned to each region. The regions, and their representative cities, are:

Northeast and Great Lakes	-	Boston
North Central and Northwest	-	Chicago
Southwest	-	San Francisco
Southeast	-	Atlanta
East Central	-	Baltimore

FIGURE VI-1. REGIONAL DIVISIONS AND REPRESENTATIVE CITIES

In selecting the cities, two criteria had to be satisfied. Each city had to be typical of its region in both climate and residential building make-up, and the city had to have been analyzed previously in the Regional Residential Energy Use series (Ref. 1).

2. Characterization of Typical Residences for Each Region

To quantify energy use within each region, new residential buildings were synthesized for each city following the methodology of previous HAI Residential Energy Consumption studies for the U.S. Department of Housing and Urban Development. Four such typical residences were developed, including a single-family (detached) house, a townhouse, a low-rise apartment building, and a high-rise apartment building for each region.

The design and structural features considered important in defining these residences included:

- structural parameters such as construction details, dimensions, and materials used, and
- energy consumption parameters such as heating and cooling equipment, types of fuels and energy used, and appliance energy consumption levels.

Whereas specific life-styles were not prescribed for the residents of the characteristic residences, a certain number of life-style parameters were imposed, by necessity, for the analyses. Examples of life-style parameters that were imposed include:

- Thermostat set points
- Relative humidity set points
- Type and number of appliances
- Daily profile of appliance usage
- Usage of ventilation fans

Most of these parameters were defined for average conditions; no attempt was made to modify the parameters to allow for variations caused by weekends or holidays, vacations, entertaining of large groups, difference in age or affluence of the residents, etc. Occupancy loads were, however, adjusted for weekends. In consideration of the sizes and quality of

the characteristic residences, and of the appliances included in these residences, it can be assumed that the residences would be occupied by individuals or families in the middle income group. It should also be recognized that the life-style of any given resident (in a real case) could vary greatly from the average conditions defined for these analyses, and that variations in occupant life-style can affect the building's energy consumption in a non-negligible way.

Current trends in each area's housing were identified by contacting a large number of area builders and acquiring data for a large number of residential buildings constructed in that area. Based on this informal sampling, and data provided by the Department of Housing and Urban Development, compatible sets of building parameters were synthesized to represent complete residential structures typical of each city.

The single-family (detached) residence is still the most prevalent form of housing in the U.S. In 1973, some 64 percent of the existing stock of year-round dwelling units nationwide were in single-family buildings (Ref. 2). Recent demographic trends, combined with costs of building materials, land, and financing, however, have begun to diminish the domination which the single-family home has held. In 1973 only 55 percent of the dwelling units started nationwide were single-family residences.

In this context, the term "single-family residence" refers to the completely detached single-family house. Quantitative data for design and structural features of single-family residences was obtained from the National Survey of Builder Practices (Ref. 3). This survey included over 1600 builders nationwide, who were responsible for the construction of approximately 84,000 single-family homes in 1973. Information was gathered on construction details, building materials used, heating and cooling equipment, and appliances used.

For the townhouse residences, the primary source of data was the same as for the single-family residences, the National Survey of Builder Practices (Ref. 3). Of the 84,000 housing units constructed nationally by surveyed builders, 19 percent, or approximately 16,000 units, were townhouses. In addition to the builder practices survey, the earlier data collection and townhouse specification done by HAI under contract to HUD (Ref. 8) for the Baltimore/Washington area was used for reference. Other sources included standard engineering and construction handbooks (Refs. 6, 7). Compatibility among building elements was carefully preserved.

The primary source of data used for the specification of low-rise building components was a very recent nationwide survey (Ref. 4) of builders who had built single-family, townhouse, and low-rise residences in the past year. This survey was performed from May 1975 to September 1975, and covered only dwelling units built during 1974. The survey was responded to by about 9000 builders, who had built approximately 200,000 dwelling units in 1974. Based on government figures of approximately 1,300,000 dwelling units built in 1974, this represents a composite sampling rate of approximately 14 percent. HAI's previous low-rise data acquisition work for HUD (Ref. 5), wherein a similar specification was done for the Baltimore/Washington area, was consulted as a reference. Judgements based on previous experience were made where necessary to ensure compatibility among building elements.

High-rise residences are defined as residential structures having more than four stories. They typically have mechanical elevation. High-rise buildings have traditionally been renter-occupied, but recent years have shown an increasing tendency towards owner-occupied, or condominium, units in many of the U.S. central cities. The data acquisition for high-rise buildings was accomplished entirely by telephone communication with builders, architects, and engineering consultants in each city studied. Sources were asked if their opinions on the characteristics of high-rise buildings in their city could be considered representative of the majority of such buildings in their city. Sufficient contacts were made to establish and verify a complete picture of high-rise residential building construction for the area. Compatibility among building components selected for each city was carefully preserved during the analysis.

A breakdown of housing types for each region was computed based on 1970 census data, using regional growth rates to project the figures through 1990. This projection is based on future heads of households, most of whom were born before the last census, implying a very accurate projection base. This projection may be found in Appendix D.

3. Regional Heating and Cooling Load Calculations

Annual heating and cooling loads were calculated for each of the four characteristic residences defined for each area. To determine the heating and cooling loads, or heat delivery/removal requirements for each residence, a time-response computer program was used. This computer program includes subroutines for computing hourly load contributions throughout the year due to conduction, convections, air

infiltration, radiation, and internal heat gain. The heating and cooling loads for each residence in each region are presented in Appendix D.

4. Regional Load Correlation Determination

To convert the energy requirements (loads) into energy use figures, the requirement must be divided by the HVAC system efficiency. For a regional load, as developed above, the efficiency must be a population weighted average of the various system efficiencies in each region. For example, in the South East region, 83.8 percent of the housing units use fossil fuels, which typically are converted to space heat by a furnace at 70 percent efficiency, and the remaining 16.2 percent of the houses use electric energy for heating, which (including power plant losses) is converted to heat at 31 percent efficiency. Therefore, the regional efficiency can be computed as:

$$\text{Regional Efficiency} = (0.7 \times 0.838) + (0.3 \times 0.162)$$

A comparison of city weather data and regional heating and cooling degree-day figures shows that both Boston and Chicago are warmer than the corresponding regional average. For this reason, the heating loads for these regions have been multiplied by 1.23 and 1.14 respectively, to adjust for the climatic differences. See Appendix D for the regional heating and cooling loads (adjusted), composite regional efficiencies, and resulting regional energy consumptions. A correlation check is included using comparison data from Reference 9, which represents regional energy use data derived from utility sales reports. Excellent correlation exists for the analysis of the Northeast, Northwest, and Southwest regions, and the other two regions show adequate correlation.

C. Projected Energy Savings With and Without Certification or Listing Barriers

Baseline data has now been fully developed and national energy savings for the selected products can be calculated using the following methodology:

- Convert the market baseline data in Appendix D to capture potential figures by multiplying those figures by appropriate product saturation values. For example, the retrofit flue gas damper capture potential includes existing homes equipped with gas or oil furnaces.

- Perform an economic analysis of the product to determine its annual fuel savings in dollars; cost effectiveness, and payback period.
- Apply the economic data to the market penetration model to determine market penetration rates with and without certification barriers for each housing type in each region.
- Calculate total energy savings by multiplying the product's capture potential by the penetration rate of the savings (in therms) per unit. This must be done for each housing type in each region, for both with and without certification barriers.

The following sections summarize the analysis of each selected product:

- (1) Flue gas damper.
- (2) Heat-only heat pump
- (3) Instantaneous water heater
- (4) Flue heat recovery unit
- (5) Infrared quartzite space heater
- (6) Urethane insulation

1. Flue Gas Damper

The flue gas damper is analyzed as a retrofit device (since dampers as an integral part of a new furnace have no certification problems) on existing single-family and town-house buildings currently using oil and gas furnaces, with a resulting energy savings of 15 percent of the heating load. Low-rise and high-rise buildings are not considered because the product exhibits negligible savings in large buildings.

The following points should be made about the economic analysis of the flue gas damper (see Appendix D):

- The flue gas damper is only cost effective in three regions: the Northeast and Great Lakes, the East Central, and the North Central and Northwest.
- Due to larger heating loads, the single-family residences exhibit larger per unit energy savings with installation of the damper. This results in higher cost effectiveness and shorter payback periods for the single-family residence as compared to the townhouse.

Due to the high market restriction caused by the lack of certification, the availability coefficient was assigned a value of 0.0.* This implies that the entire natural market penetration has been eliminated by building codes requiring certification of retrofit flue gas dampers.

A second market penetration calculation was performed, assuming immediate and complete removal of the certification barrier. The penetration model was adjusted by changing the availability coefficient from 0.0 to 1.0, corresponding to no penetration restriction associated with certification. Analysis was then performed as described above. The national savings without the certification barrier and the net savings resulting from the barrier's removal were computed. These net savings are compared with those resulting from the increased market penetration due to barrier removal of the other analyzed products in Appendix D.

2. Heat-Only Heat Pump

By the very nature of the product, a heat-only heat pump will be more than marginally applicable only in climates that require significantly more space heating than cooling. This is due to the fact that, in order to out-perform a conventional heat pump (on a cost-effective basis), the increased heating C.O.P. of a heat-only heat pump must result in a large enough heating-related energy use reduction to over-compensate for the increased cost associated with installing an additional air conditioning system.

Based on this fact, the analysis will be restricted to single-family and townhouse units located in the East Central, Northeast and Great Lakes, and North Central and Northwest regions. Only retrofit installations will be considered as potential applications of the product, since this is the only application with certification barriers. Due to the large losses associated with electricity generation (on the order of three units of energy expended to generate one unit of electricity), even a high efficiency electric heat-only heat pump cannot compete with fossil fuel fired furnaces on a primary energy use basis. Therefore, any energy savings resulting from a heat pump used for heating will stem only from complementing an electric system. Thus, adding a heat-only heat pump to an electric furnace system will be the actual situation analyzed. Baseboard radiation systems are not considered since the retrofit cost of installing duct work would be prohibitively expensive

*This coefficient is an input to the market penetration model.

The heat-only heat pump has been assigned an average C.O.P. of 2.0 for the northern regions. According to information obtained from Janitrol,* this is a very realistic figure. Since electric baseboard radiation and electric furnace heating approach efficiencies of 1.0, use of the heat pump will result in a 50 percent decrease in energy used for heating. Economic analysis based on this savings figure is presented in Appendix D. Included is the cost effectiveness and payback period for the unit in single-family and townhouse residences for the three regions studied. Due to larger heating loads, implementation of the heat pump is more cost effective in single-family units than in townhouses.

As was the case in the previous analysis, the economic data has been input into the market penetration model to determine future sales of the product. Penetration rates both with (market availability function = 0.1) and without (availability = 1.0) barriers have been computed and the resulting energy savings are in Appendix D. Net savings resulting from the removal of certification barriers have been calculated, and a comparison of these savings with those associated with other products and barriers is also in the Appendix.

3. Instantaneous Hot Water Heaters

This product uses electricity to heat water. Due to the large energy losses associated with generating electricity, even a high efficiency (0.98) instantaneous water heater cannot compete with fossil fuel fired heaters in terms of primary energy use. In light of this fact the following analysis will only consider replacing existing or new electric water heaters with the instantaneous model. Comparison of water heating energy use in different climatic regions has shown that there is little variation in energy use with climate. This fact allows the use of national, rather than regional analysis of the product, which greatly simplifies the process.

Based on information in a news letter from Chronomite Labs (a producer of instantaneous water heaters), a water heater with the capacity to meet a typical family's demand costs \$70 plus installation, a total cost of about \$100. In 1975, according to Merchandising Magazine*, the average

*A heat-only heat pump manufacturer.

**March 1976 issue.

retail price for a hot water heater was \$107 plus installation. Based on this data, the instantaneous water heater will be analyzed as both a new installation and a retrofit installation, competing with electric water heaters of conventional design.

Economic analysis was performed for both the retrofit and new installation market. A differential cost of -\$37 was used for the new market, since the alternative to a \$70 instantaneous heater is a \$107 holding tank model. A differential cost of the full \$70 plus installation was applied to the retrofit market, since a functional heater was assumed to be replaced.

This economic data has been input into the market penetration model and the resulting penetration rates for both new and retrofit installations have been applied to the appropriate capture potentials, resulting in national energy savings for penetrations both with and without barriers. The net savings resulting from the certification barrier removal are compared with other product's savings in Appendix D.

4. Flue Gas Heat Recovery Devices

A wide range of flue gas heat recovery devices are presently on the market, including heat pipes, enthalpy wheels, and run-arounds. These products have diversified applications and cover the entire spectrum of residential HVAC systems, from single-family units to large high-rise systems. It is obvious that the products will be cost effective only in the three Northern regions. Heat recovery units are applicable in all fossil fuel furnace heating systems, typically resulting in about eight percent energy use reductions. The products are currently encountering major certification problems only in retrofit applications, thus this is the market that will be analyzed.

An economic analysis based on eight percent energy savings and on initial cost of \$100 (installed) per unit has been done. It can be seen that the flue heat recovery devices proved to be cost effective in both single-family and town house units in the North East, and only single-family units in the North West and East Central regions. The economic data was input into the market penetration model and the resulting penetration rates were then used to determine national energy savings with and without barriers. A product availability of 0.1 was assigned for retrofit units with existing barriers, reflecting their present limited sales. The results of this analysis are in Appendix D.

5. Infrared Quartzite Space Heaters

An infrared space heater uses direct radiation to heat bodies in a space rather than using the air as a transfer medium to transport or convect the heat from the heater to the bodies (the mechanism employed by all conventional systems). The radiation technique has two inherent advantages over convection, these being:

- quicker response time for effecting a temperature rise in a body, and
- an ultimate energy use reduction due to decreased infiltration and conduction losses.

Perhaps the most advantageous way to employ infrared heaters is in industrial applications (such as in warehouses) where there are large amounts of air that need not be heated. However, substantial energy savings potential also exists in the residential sector. Infrared heaters can be used in conjunction with conventional electric space heaters in such a way as to reduce net energy use. A heating set point temperature of 60°F, comprised of 80 percent conductive heating and 20 percent radiation heating, will be comparable on a comfort basis with 70°F comprised of 100 percent conductive heating. The 10° set point reduction will typically result in a 40 percent energy use reduction.

A system of this type would be most advantageous in a house with electric baseboard heating, since this type of heating is typically zone controlled, thus allowing each room to be kept at different temperature. The quick response time of the infrared heater will allow the use of heating energy only when needed due to people in the room.

The capture potential for this product includes all residential units with electric baseboard heating. A regional analysis is necessary due to the obvious relationship between climate and cost effectiveness of the product.

An initial cost of \$100 and a savings of eight percent were assumed for one heating unit - capable of warming one room. The economic analysis shows the unit will only be marginally cost effective in low and high-rise units due to rental price inelasticity and master metering. Certification for this product required over one year, thus one year's savings will be assumed lost in analyzing the effect of certification barriers.

6. Urethane Wall Insulation

Urethane wall insulation has been used in new low-rise multifamily construction to reduce wall U values to less than 0.027. Coding restrictions subsequently imposed without thorough testing have forced manufacturers to use instead a very similar insulation at equal cost which results in an equivalent wall U value of 0.032. Though either product improves typical wall U values (e.g., 0.076) greatly, removal of the barrier could save an estimated two percent of heating energy use in new buildings receiving the urethane insulation.

As no first cost can be associated with the improved insulation, the resulting savings are viewed as free. The product is assumed applicable (with increased energy savings) to new, low-rise multifamily dwellings in the Northeast and Great Lakes, the East Central, and the North Central and Northwest regions. The projected cumulative energy savings due to barrier removal reached 0.002 Quad by 1990 (see Appendix D).

D. Methodology to Rank Barriers

The following is a brief description of the methodology used by the HAI staff to provide ERDA with a preliminary ranking of the certification and listing barriers identified in Chapter V. These barriers were resubmitted to HAI for further analysis (Chapter VII).

The barriers were ranked according to the net energy use reduction associated with their removal. The previous analysis in Section C determined the energy savings associated with product classes. Thus in order to translate this information into barrier-specific data, an analysis of the barriers encountered by each product has been conducted. The relative importance of each barrier contributing to a product's market penetration restriction has been included.

Table VI-1 lists the products analyzed in Section C in order of net energy savings associated with complete certification barrier removal. A comprehensive checklist of system features has been incorporated into the table, using a correlation ranking to specify the contribution of each particular features barriers to the net energy conservation restriction. The products have been assigned a weighting value that reflects their net energy savings relative to each other. By multiplying the barrier correlation factors by the product weight and summing over all the products, an energy savings-based ranking of the features can be established.

TABLE VI-1. BARRIER RANKING

Barriers Products	Product Weighting	General Institu- tional Constraints	Due Process Constraints	Testing Constraints	Standards Develop- ment	Economic Constraints	Legal - Constraints
Flue Gas Damper	0.93	0.20	0.05	0.05	0.50	0.10	0.10
Instantaneous Water Heater	0.68	0.05	0.40	0.25	0.05	0.20	0.05
Heat-Only Heat Pump	0.59	0.15	0.10	0.05	0.40	0.20	0.10
Flue-Gas Heat Recovery Device	0.46	0.20	0.05	0.05	0.40	0.20	0.10
Infrared Space Heater	0.006	0.15	0.20	0.05	0.20	0.30	0.05
Urethane Insulation	*	0.20	0.05	0.05	0.30	0.10	0.30
Barrier Total	-	0.40	0.40	0.27	0.92	0.44	0.24

* negligible

It should be emphasized that national energy savings is not the only factor to consider when analyzing a particular barrier. Minimization of institutional conflict, maintenance of proper health and safety standards, detailed economic impacts, and other considerations must be treated as criteria or constraints within which the barriers may be removed. For example, removing a particular barrier might reduce national energy use by a significant amount, but this will only be deemed desirable if the health and safety of the public has not been compromised, institution conflict has been kept to a minimum, etc.

The results of the system feature ranking as illustrated in Table VI-1, show that, in order of importance as related to energy savings, the features are:

- (1) Standards Development,
- (2) Economic Constraints,
- (3) Due Process Constraints,
- (4) General Institutional Constraints,
- (5) Testing Constraints, and
- (6) Legal Constraints.

After ranking these generic barriers to provide structure to this ranking effort, the next step was to identify and rank more specific barriers within these generic categories. The methodology used here was a workshop, which is described in Appendix E. The top-ranked specific barriers identified in the course of the workshop were selected by ERDA for further investigation. The objective of this final phase of the project was to develop workable programs and policies to possibly mitigate the barriers selected by ERDA from the list presented. This final effort is summarized in the next chapter.

E. References

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VII. POSSIBLE ALTERNATIVES TO MITIGATE BARRIERS

The preceding chapters have identified specific features of the existing certification and listing system that result in barriers to the marketing of new products. Possible future energy savings precluded by these barriers were quantified for six products presently in, or recently through, the certification process. It has been determined that the identified barriers not only result in higher priced products, delayed market entry, and altered design for new products; but also act as a deterrent to production innovation. For these reasons it would be beneficial to the country to mitigate these barriers as effectively as possible.

The first and most obvious solution is the complete abandonment of the voluntary certification process. This approach would remove all barriers associated with certification, but most individuals agree that other undesirable effects of such an action would outweigh the improvements. The certification process both protects consumers from unsafe products and serves as a way for manufacturers to assure the public that new products are in fact safe. The concept of eliminating certification is therefore not a very worthwhile one. However, the desired results of a comprehensive certification program can be attained without also presenting the barriers to new products that are now in evidence.

This chapter first explores specific micro-solutions for each barrier, and then presents complete programs designed to implement these solutions. When possible, qualified initiating government agencies, precedents for similar programs, and problems that will be encountered in conducting the programs have been identified.

A. Micro-solutions to Barriers

For each barrier selected by ERDA from the prioritized list in Appendix F, specific solutions have been presented below. It should be noted that these solutions are only outlined in brief at this point, and have been fully developed into implementable programs in Section B of this chapter. The barriers analyzed include:

- lack of an information source on how to use the certifying system,
- limited number of nationally recognized testing labs,

- high costs of testing,
- absence of performance standards,
- product liability (from the manufacturers', financial organizations', and certifying laboratories' viewpoints), and
- length of time required for certification.

1. Lack of Information

The certification system is used by, and thus affects, a wide range of manufacturers, from large corporations with dozens of products and a full-time certification staff; to one-man companies with extremely limited financial assets. There is a large correlation between innovation and firm "newness" and/or "smallness" in the manufacturing industry. As explained in Chapters III and V, the existing certification system presents significantly more barriers to new and innovative products. The above two facts make it obvious that the small, inexperienced and uninformed manufacturer bears the brunt of the certification problems. This being true, the present lack of available information regarding certification acts as a primary barrier to the small manufacturer. With regard to this barrier, three basic solutions are worth considering:

- (1) an information dissemination office,
- (2) simplification of the existing certification system, and
- (3) increased service provided by the existing certification institutions.

The existing institutions provide complete, up-to-date information about their own services and requirements, but little information is available to the manufacturer regarding the system as a whole, or where to begin. For this reason, the information that is lacking - and that would, if made available, have an appreciable impact on the existing barriers - is "up-front" information or basic guidance to the uninformed manufacturer. An office could be created to disseminate this information to manufacturers. An alternative to educating the users of a complicated system is simplifying that system, thereby eliminating most misunderstanding and confusion. This might be done by streamlining the system or by standardizing unique but similar institutions to remove unnecessary and complicating disparities. A final possibility is requiring the existing certification organizations to provide more extensive broad-based information to inquiring manufacturers.

2. Limited Number of Certification Agencies

The few recognized certification agencies appear not to be large enough to expediently test all the products that are submitted to them for certification. This lack of capacity typically manifests itself in significant backlogs and long time requirements for certification. The almost exclusive domination of certification by several agencies also results in a quality of service perhaps somewhat less than that provided in a competitive atmosphere. Three alternatives exist for dealing with the limited number of certification labs, including:

- (1) increasing the number of private certification labs,
- (2) increasing the capacity of the existing labs, and
- (3) creating government labs.

Increasing the number of private certification labs would be futile unless accompanied by a modification of building codes to accept the new labs, and some accreditation program to identify those labs that are - and more importantly those that are not - providing stringent enough testing to assure that only safe products are being certified. In order to motivate capital investment in new certification agencies, the status of these institutions would have to be changed to a profit making one. (Obviously the original motivation for insurance companies to finance testing labs; i.e., decreased liability claims resulting from unsafe products, is no longer applicable, since certification is now "required" to successfully market most products.)

Increasing the size of the existing labs or organizing government labs might reduce backlogs, but would in no way guarantee the higher quality of service associated with stimulated competition. There well might be another drawback to increasing the capacity of the certification system, that being increased costs resulting from larger overhead structures and increased payrolls.

3. High Certification Cost

As previously stated, new small firms typically incur a larger cost in obtaining certification than do large firms. Obviously, these small companies are less able to finance costly certification programs. This financial pressure can be alleviated in two basic ways, by reducing the charged cost of certification, and by subsidizing the firm's payment of certification costs.

The charged cost can be reduced in three ways:

- (1) introducing price-cutting certification competition,
- (2) subsidizing the certification labs, and
- (3) educating the firm so it will be as efficient as possible in getting certification.

These price-reducing solutions are indirect at best, and place no emphasis on reducing first-time certification costs, which have been shown to be disproportionately large.

Subsidizing the firm is direct and allows the use of any priority desired - such as complete financing for products deemed capable of reducing national energy use. This solution also would allow increased subsidization for first-time certification.

4. Lack of Performance Standards

The lack of performance standards or, more exactly, the extensive use of prescriptive standards, has been cited as a strong barrier to obtaining certification for innovative products. When a new product is submitted for testing, the existing prescriptive standards either cause the product to fail only because it is different, or require the development of new standards, a very costly and time-consuming process. This obviously unjustly penalizes innovative manufacturers and discourages future innovation. To mitigate this barrier, three possible solutions exist, including:

- (1) private sector standards revision,
- (2) government standards development, and
- (3) better informed firms.

Although private standards revision is now beginning, the typical approach is to redevelop a prescriptive standard into a performance standard when the need for such a modification arises. This obviously creates a barrier for the firm whose product required the new standard. However, it is unfeasible that a more extensive revision of the existing standards be undertaken, given the consensus method of standards development presently used. For this reason, a government revision might have a faster impact on the bulk of the existing standards. Problems associated with this approach include a lack of the comprehensive technical expertise required to restructure the diverse group of

standards in question, and the possibility that a majority of the revised standards might not be re-used for new products.

Given the aforementioned problems with revising an existing set of standards, the third alternative, informing the firms, might prove the most effective in the short run. To a certain extent, a manufacturer can modify his basic design to meet the prescriptive standards that apply to it, thus eliminating most certification problems. However, some very innovative designs will not be able to be revised to fit into the existing standards framework, rendering this solution only partly effective at best.

5. Liability Concerns

With the recent increase in liability suits being filed throughout the nation, a new liability awareness has begun, which typically fosters an extremely conservative approach to such activities as product safety certification. This conservative attitude is responsible for the use of highly rigid testing procedures and strict standards. In an attempt to remove any undue liability pressures on certification labs and manufacturers, the liability responsibility could be shifted to:

- (1) the government,
- (2) the consumer, and
- (3) an insurance company.

Although precedents for government insurance programs exist, it is unlikely that a liability problem would best be solved by making the government responsible. The same holds true for shifting the liability to the consumer - this action would tend to discount the overall benefit of the certifying process, a process which has already been deemed worthwhile. The possibility of a private liability insurance program for products is good, and at first inspection seems feasible. The affected parties would pay some premium to an insurance company that would in turn accept financial responsibility for any liability claims filed against its policy holders.

6. Long Certification Time

One of the most deep rooted problems with the existing system, characterized by a very few certification labs and a consensus approach to standards development, is the long lead time required to obtain certification. This wait is costly to both large and small manufacturers - the large firms suffering sub-

stantial idle-time costs, and the small firms fighting to remain solvent without any sales revenues. Although a new innovative product will require a longer time to develop standards and testing procedures than a common product, certain changes might be made in the existing system to reduce the required time. These include:

- (1) avoiding backlogs,
- (2) streamlined standards development, and
- (3) better informed firms.

Each of these actions have been discussed previously in regards to other barriers and thus it is assumed that they are clear at this time.

B. Programs to Implement Solutions

A primary objective of this report is to assist ERDA in planning programs and setting priorities associated with encouraging the commercialization of new and retrofit energy conserving products currently being restricted by certification and listing practices and procedures. In providing this assistance, several possible programs will be identified and discussed. Below is a list of program categories from which more specific programs will be identified.

- Financial Subsidies,
- Information Dissemination,
- Certification Alternatives,
- Certification Process Simplification,
- Liability Relief, and
- Review Bodies.

These programs represent the supportive role that government may play (as opposed to an active role or direct manipulation) in the certification and listing process.

Most certification and listing agencies and standards development bodies are privately organized and financed. Direct Federal involvement in this self regulating process is viewed as a threat to the private sector's maintenance of the system.

Further, the Federal government is not fully equipped to efficiently operate such a broadly based technological and societal need. The National Bureau of Standards and the General Services Administration both attempted to play an active role in standards development and listing of products, but neither of these organizations could cope with, or expand at a growth-rate commensurate with the pace of technological advancement. These organizations did not have the broadly based technical expertise to deal with all new products requiring either special tests or new standards developed for evaluative purposes. The experience and responsiveness of voluntary standards-making bodies and testing laboratories in the private sector have supplied and will continue to supply certification, listing, and standards development services supported by self-regulating trade and professional associations, noted certification and listing agencies, standards-making bodies, and others. The Federal government, by considering and implementing the following suggested programs, may impact the certification and listing process while maintaining a supportive role by encouraging, stimulating, and accelerating the diffusion of energy conserving products and other products to the marketplace.

In the following sections of this chapter, possible programs to assist in overcoming the existing certification barriers will be identified and discussed. These programs will each incorporate several micro-solutions previously outlined in this chapter.

1. Financial Subsidies

The primary objective of implementing subsidy programs is to reduce - through loans or grants - the high costs associated with certification and listing incurred by manufacturers. As noted earlier, manufacturers are sometimes discouraged from submitting a product to certifying institutions due to the high costs associated with obtaining certification and listing. Three programs have been identified which would enable manufacturers to more easily finance certification and listing:

- subsidize manufacturers,
- subsidize standards development, and
- subsidize certification and testing laboratories.

a. Subsidize Manufacturers. A loan should be made available to manufacturers of new products seeking certification and listing. The loan should not exceed a designated fraction of the total cost for certification and should be made payable when the firm becomes a solvent producer of the product.

Implementation of such a program would cause a reduction in time spent obtaining loans by manufacturers seeking certification (see Janitrol case study). Although such a subsidy may not accelerate product market penetration, it will act as a stimulating agent to new manufacturers who may have otherwise been discouraged to submit a product due to excessive costs.

This subsidy may be funded by several Federal agencies. The Small Business Administration could support small manufacturers who lack sufficient funds to enter the system. The National Bureau of Standards along with the Energy Research and Development Administration have initiated a program called the Office of Energy Related Inventions. This Office is chartered to provide partial funding for new and innovative energy saving inventions. To this end a number of agencies may want to participate; including Department of Transportation, Department of Housing and Urban Development, Federal Energy Administration, and others. The Federal government has provided assistance to private sector projects which ultimately benefit the American public. Also, by allocating funds to manufacturers seeking certification, it becomes a manageable task to track funds and identify how they are being utilized.

There are several problems associated with this particular subsidy. First, establishing the criteria for equitably distributing these funds becomes a critical task. Second, determination of the fraction of costs associated with product certification to be supplied by the Federal government will present some conflict. Third, it is important that firms are made aware of the suggested funding program. And, perhaps most critical, for those products that are government supported and fail to pass certification programs, some recourse or alternative action should be identified.

b. Standards Development. The Federal government should make funds available to a standards development committee for the development of a standard if required for the certification of a product. Also, a committee to review the associated costs of standard development should be created. The cost of standards development is presently passed on to the manufacturer, which inhibits market penetration. Through this program several positive impacts may arise. Financing of standards development will allow the Federal government to support the institutionalizing of performance standards. Also, this program will provide the Federal government with the ability to directly monitor the development of new energy conserving products coming to the marketplace. And finally, the cost passed on to the manufacturer would be reduced.

Two agencies that may take the lead in initiating such a program are: the National Bureau of Standards and the Energy Research and Development Administration. Both of these agencies have recognized interests in this particular area. NBS is interested in performance standards development and in all aspects of technological advancements. ERDA could become more involved in aiding performance standards development for energy conserving products by reducing a major cost of certification encountered by manufacturers of such products. The Federal government has in various programs initiated this type of program. For example, the Environmental Protection Agency, in their efforts to develop standards for environmental quality, has provided funds to private sector organizations to define acceptable safety standards for emissions. Similar types of funding can be provided to develop safe and reliable product standards while encouraging the entrance of new and innovative products.

To implement this program, a better definition of the costs associated with standards development must be established. Presently, standards arise from a variety of sources: certification and listing organizations, standards-making groups, military institutions, other public sector sources, trade associations, and others. Because of the multitude of mechanisms available for standards development, not being able to identify a specific standards development body or committee to fund may cause some difficulty. And also, defining equitable and suitable criteria for disbursement of these funds will need to be reconciled.

c. Subsidize Certification Laboratories. The Federal government may want to subsidize testing laboratories, but this action is not desirable for two reasons. The first is that the desired effect of such action is redundant with allocating money to the manufacturer. And second, allocating funds to testing laboratories will cause many conflicts with interests who now support the current certification and listing process and who are hesitant to accept Federal involvement in private sector organizations.

Of the three suggested programs, the most desirable would be to make funds available to manufacturers seeking certification and listing. This action would allow the Federal government to support and emphasize product development in areas which would best serve societal needs. And this program would serve to stimulate innovation in the commercial sector.

2. Information Dissemination

Programs need to be developed to make available to manufacturers and any other interested party information that would assist in obtaining certification and listing. This information should include whatever is needed to clarify for manufacturers the requirements of the certification and listing process, practices, and procedures. Two primary ways which this information can be disseminated are: 1) through a government office and 2) through a private organization.

a. Government Office. A Federal office should be created to disseminate information using easily updated and readily accessible methods, such as:

- toll free telephone numbers,
- referral office with a computer based center,
- pamphlets,
- National Technical Information Service,
- regional information offices (county agent type programs),
- technical and business magazine articles, and
- other appropriate methods.

The result of implementing such a program would be to cause a reduction in cost and time for manufacturers. Presently, a major barrier to certification and listing is attributable to the manufacturers' lack of knowledge of that system. With this initial information, a manufacturer would be able to move his product more efficiently through the certification and listing process. Thus, from this new awareness, a manufacturer will be able to avoid (or prepare) for potential obstacles.

Federal organizations which would be effective in implementing such a program would be the General Services Administration, Small Business Administration, and National Bureau of Standards. The General Services Administration, which lists products and actively participates on standards development committees, has the expertise to coordinate and administer such a program. The Small Business Administration with its regional offices may provide an already existing capability to organize and disseminate this information. Further, the National Bureau of Standards has the experience and knowledge of standards-making bodies, code groups, manufacturers, and others to properly represent and express how each of these bodies operates and func-

tions. Such information dissemination offices are commonly organized by Federal agencies. For example, technology transfer offices, public relations offices, publications offices, library references and services, and other Federal programs are currently involved in making the public more knowledgeable of private sector as well as public sector activities.

Several problems arise when originating such a program. It would be the responsibility of such an office to update, make available, adequately represent, and channel information to those whom it is intended to aid. These problems are not easily overcome, but the experience in information dissemination of the aforementioned Federal agencies would make this a credible as well as feasible alternative.

b. Private Office. The government could encourage the development of a private office to disseminate information using an easily updated and readily accessible method such as those mentioned in the previous program, but charging a minimal fee for this service and/or supported by the institutions who currently develop standards and certify and list products.

The major benefits of encouraging the development of this office are two-fold. First, it would cause a reduction in cost and time for manufacturers who otherwise would not have had advanced knowledge, thus allowing manufacturers to make efficient use of the certification process. Second, such an office would allow certification, listing, and standards making-bodies to appropriately update, revise and represent their particular institutions to manufacturers.

An agency likely to initiate such a program might be the Federal Trade Commission, whose interests lie in reducing restraints in trade due to monopolistic practices, antitrust actions or other restrictive mechanisms. Other potential initiating bodies previously mentioned would be the GSA, NBS, and ERDA, all of which have specific interests in product diffusion to the marketplace. Precedents for such a program have been mentioned (i.e., public relations offices).

The major problem associated with information dissemination is making the potential user of this information aware that the information is available. And also, the other problems mentioned in the previous program may be applicable to such private sector programs.

3. Certification Alternatives

The purpose of developing certification alternatives is to decrease certification backlogs by increasing the number of certification and listing agencies. The limited number of certification alternatives has consistently been identified as a major barrier to obtaining certification.

A program to mitigate this barrier would be to assign the Federal government the responsibility to accredit certification and listing agencies, thereby encouraging the development of more certifying agencies. Presently there are only a few nationally recognized certifying and listing agencies. The accreditation program would promulgate the credibility of other certifying agencies. To motivate capital investment in these agencies, they must be profit-making. (U.L. is a non-profit listing organization which was created by insurance agencies. Due to recent actions, many insurance agencies have reduced their role in supporting U.L. Currently, testing laboratories must rely on product certification monies for income). Also, this program will encourage local code officials to revise codes to recognize any government accredited agency.

One impact expected to result from enacting such a program would be that the competitive nature of certification may decrease the costs and increase services to manufacturers. Further, to increase certification revenues, an agency will attempt to expedite the development of standards and also try to reduce the number of inefficient practices within the certifying and listing process. And finally, the code revision process may provide the vehicle to support performance standards while acting to increase product innovation.

Precedents for such a program were developed in anti-trust legislation, specifically Senate Bill 3555. Also, accreditation programs for health facilities and other institutional standardizing endeavors provide models that could be utilized for accrediting certifying facilities.

Opposition to such a program would most likely arise from established certification, listing, and testing laboratories. Justifying the funding for accreditation to Congress and the President may prove to be a burdensome task due to the number of conflicting interests that may chose to oppose such a program.

4. Certification Process Simplification

The reason for developing a program to make the process of certification simpler is to decrease confusion, cost, and time associated with certification and listing. Three possible ways in which the process can be simplified are through horizontal conglomeration, vertical conglomeration, and standardization of the certifying process.

a. Horizontal Conglomeration. This program would be Federally initiated and would encourage combining existing standards development committees and certifying organizations into single agencies, i.e., reorganizing the existing system into one standards making body, one certifying agency, etc.

This program is not feasible due to the number of special interest groups who would not favor or support such a system.

b. Vertical Conglomeration. This program would allow and encourage each certification and listing agency to develop all required standards.

Once again, this program is not feasible due to the probable opposition of institutional concerns.

c. Standardization of the Certification and Listing Process. The Federal government should encourage the voluntary restructuring of existing certification and standards development systems to reduce ambiguities and redundancies, and make uniform the procedures used by similar certification and standards development agencies. Before implementation of such a program, the Federal government should initiate feasibility studies to examine the possibility of alternatives to the present system. Such a program would increase the diffusion of innovative products to the marketplace.

NBS, FTC, and ERDA would be three lead agencies to conduct program feasibility studies and follow-ons with emphasis on those programs deemed suitable and consistent with the programmatic charters of these Federal agencies. For example, NBS may want to exclusively review standards development and code development alternatives. FTC may want to be active in the liability and restraint of trade aspects of the standards development and certification system modifications. ERDA may want to look at product-specific cases of certification and listing to evaluate where ERDA could effectively accelerate energy-conserving product certification in a safe, reliable, and cost-effective manner. Various Federal government agencies have per-

formed studies of this type in the past.

Institutional conflict will act as a primary obstacle toward implementing any change to the status-quo of certification. But feasibility studies conducted by credible private firms, familiar with the problems, people, and institutions involved in the certification process may prove to be an effective means to reduce skepticism of results attained. A major benefit of this program would be an increase in the number of innovative products that would pass through the process.

5. Liability

The question of liability has proven to be of major concern to parties directly involved with certification and listing. Particular concern has been voiced by the certification and manufacturing organizations, who are sensitive to the possibility of legal suits arising from an accident with a product that has been certified to be safe. Certifying agencies are therefore extremely conservative in conducting product safety tests.

A program should be developed to moderate this conservative approach by reducing the liability associated with product failures. Liability could be reduced by developing an insurance program for certifying agencies; shifting liability to the Federal government; and by shifting liability to the consumer.

a. Insurance. An insurance program funded by the payment of premiums by the affected agencies could be established to protect those agencies from liability. This type of insurance might be provided by an established insurance company or by the Federal government.

Three secondary benefits would arise from such a program: accelerated standards development activities, less restrictive certification practices, and an increase in innovative products reaching the marketplace.

The Small Business Administration might be able to sponsor such a program.

The primary obstacle confronting this program would be the high cost of premiums which would tend to increase certification costs. If this problem could be resolved, an insurance program would increase innovation since certifying agencies could be more flexible in their testing practices.

b. Shift Liability to the Federal Government. The Federal government could assume full responsibility for unsafe products, as it does for deposits in Federal banks (FDIC). There are a multitude of problems associated with such an alternative, the most notable being taxpayer reluctance to pay the price for such a program. Another problem would be identifying a Federal agency willing accept the responsibility for product failures.

c. Shift Liability to Consumer. The Federal government could develop a program to make the consumer liable for product failures. This program would not be an acceptable alternative. Consumers would not buy a product knowing they are assuming full liability for its use.

6. Review Bodies

The Federal government could develop review bodies to hear complaints of manufacturers. This alternative would tend to act as a barrier toward certification since review bodies lack the appropriate jurisdiction to be responsive to the needs of a manufacturer. Further, the manufacturer would have to spend large amounts of time and money to work with a review board. Thus, this would not be a favorable alternative, having little meaningful impact on the diffusion of energy conserving products to the marketplace.

Table VII-1 summarizes the findings of this chapter. All identified programs have been listed, along with the barriers mitigated, the expected feasibility of successful implementation, and the most probable implementing government agency for each program.

Of the six program categories, three provide programs which would significantly impact the certification and listing process and increase the market penetration of energy conserving products:

- financial subsidy programs,
- information dissemination programs, and
- certification alternatives program.

Table VII - 1. Summary of Programs

PROGRAMS IMPLEMENTING FACTORS	Subsidize Manufacturers	Subsidize Standards Development	Subsidize Certifying Laboratories	Private Sector Information Office	Government Information Office	Accreditation of Certification Agencies	Horizontal Conglomeration	Vehicle Conglomeration	Standardization of the Certification Process	Liability Insurance	Shift Liability to Government	Shift Liability to Consumers	Development of a Review Board
Barrier solved													
Lack of Information				X	X				X				X
Limited Number of Certifying Agencies						X							
High Cost of Certification	X	X	X	X	X		X	X	X				
Absence of Performance Criteria		X	X			X	X	X	X				X
Long time for Certification	X	X	X	X	X	X							
Liability										X	X	X	

Table VII - 1. Summary of Programs (Continued)

PROGRAMS IMPLEMENTING FACTORS	Subsidize Manufac- turers	Subsidize Standards Development	Subsidize Certifying Laboratories	Private Sector Information Office	Government Information Office	Accredita- tion of Certifica- tion Agencies	Horizontal Conglomera- tion	Vertical Conglomera- tion	Standard- ization of the Certifica- tion Process	Liability Insurance	Shift Liability to Government	Shift Liability to Consumers	Development of a Review Board
Feasibility	H	M	M	H	H	H	L	L	M	H	L	L	M
Federal Agencies													
Department of Housing and Urban Development				X	X								
Department of Transportation					X								
Federal Energy Administration	X				X								
Federal Trade Commission				X	X				X				
Small Business Administration	X									X			X
National Bureau of Standards	X	X	X	X	X				X				X
Council on Environmental Quality					X								X
Energy Research and Development Administration	X	X	X	X	X								X
General Services Administration	X			X	X	X			X				
Department of Commerce						X							

H - High M - Medium L - Low

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APPENDIX A - LITERATURE REVIEW

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Charles R. Montgomery, President, Michigan Consolidated
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Grandinetti, Inc.

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Letter to HAI, October 1976.

APPENDIX B - LIST OF CONTACTS

The following individuals were contacted informally as part of this research program.

INSTITUTION	NAME	ORGANIZATION	PHONE NUMBER
Government	Nerv Dizenfield	Housing and Urban Development	202-755-6590
	Scott Heider	Housing and Urban Development	Visit
	John G. Muller	Federal Energy Administration	202-964-3158
	Mr. Motes	U.S. Patent Office	203-557-3158
	John Ray	U.S. Senate Subcommittee on Antitrust and Monopoly	202-224-5573
	Richard Gore	General Services Administration	203-557-5338
	Frank McLaughlin	Health Education and Welfare	Visit
	Nick Dehass	General Services Administration	703-557-1139
	Bob Jones	National Bureau of Standards	301-921-3694
	Bob Blake	Health Education and Welfare	202-245-1900
	Bob Eisenhard	National Bureau of Standards	301-921-3361
	Bob Dicker	National Bureau of Standards	301-921-3285
	George Dewitt	National Bureau of Standards	301-921-3694
	John Chickering	Health Education and Welfare	202-245-1907
	Jim Libertine	Small Business Administration	301-962-2233
	Bob Schroeder	Federal Trade Commission	202-523-3644
	Hans Grigo	National Safety Council	312-527-4800
	Betty Bay	Health Education and Welfare	202-655-4000
	William White	Consumer Products Surety Commission	202-492-6504
	John Mooney	Federal Trade Commission	202-523-3461
	Jack Snell	National Bureau of Standards	301-921-3671
	Dwayne Keplinger	Housing and Urban Development	202-755-5718
	John McConaughay	National Bureau of Standards	301-921-3701
	Mr. J. Smith	Federal Energy Administration	202-566-9390
	Peter Armstrong	Consumer Product Safety Commission	202-492-6527
	Rosellyn Young	Federal Trade Commission	202-523-3644
	Jack Rabinow	National Bureau of Standards	301-921-3611
Manufacturers and Manufacturer's Representatives	Morris Thierman	Piess Stauffer, Inc.	212-466-0550
	Robert Russel	Chronomite Labs, Inc.	213-320-9452
	Warner Diermayer	Kutzner-Weber GMBH & Co.	415-283-2609
	Mr. Hawkins	Aerofin Corp.	804-845-7081
	Pat Dexter	Dexter Engineering	301-939-2220
	Alan Streb	Dynatherm	301-666-9151
	Jay Dowdle	Honeywell	612-870-5200
	Jack Brock	International Business Machines	404-252-2500
	Lee Sumner	Borg Warner	717-846-7890
	Arnold Nieweld	Wing Co.	201-486-7400
	Mr. Akens	Pittsburg Plate and Glass Inc.	301-659-9894
	Mr. Bookamp	Industrial Representatives	714-460-2150
	Charles E. Woolfolk	Save Fuel Corp.	901-327-1182
	Frank Gorrel	Season-All Products, Inc.	412-349-4600
	Doug Cornell	Cornell Corp.	813-971-5550
	J. Tims	Quality Steel	601-843-4046
	G. Cotton	Q-Dot	214-603-1224
	Mr. Bilek	General Electric	502-452-2639
	Sam Compton	ITT Reznor Environmental Products Div.	412-662-4403
	Tim Travis	Eaton Metals	303-825-7204
	H.H. Harris	Pittsburg Plate and Glass	301-779-4400
	Jack Bologna	Pittsburg Plate and Glass	412-434-2663
	Cliff Wood	Dexter Engineering	301-461-1477
	Bill Fitch	Owens Corning Fiberglas	419-248-8136
	Mr. Grandinetti	Grandinetti Corp	213-638-8778
	John Creeley	Cal Bar Inc.	215-RE9-8778
	---	B.F. Goodrich	216-379-2911
	Mr. Ben Gattys	Westinghouse	
	Alan Miles	Aerofin Corp.	804-845-7081
	Kathy Wooten	General Electric	502-452-3754
	Bob Albrecht	Trionic Industry	717-652-0761
	David Hart	Janitrol Div./AMERO Corp.	614-221-6492
	Paul Mink	Innovator Solar Heating Prop.	301-649-4892
	Robert A. Miller	Wholesale Gas and Supply Inc.	

LIST OF CONTACTS (CONTINUED)

INSTITUTION	NAME	ORGANIZATION	PHONE NUMBER
Certification or Listing Institutions, Standards Making Organizations, Professional, Technical and Trade Associations	Joe Demkin	American Institute of Architecture	202-785-7262
	Mrs. Heider	Building Research Advisory Board/National Academy of Science	202-389-6348
	Edward S. Charkey	American Insurance Association	212-433-4400
	Juanito Madlanghayan	Air Conditioning and Refrigeration Institute	703-524-8600
	Mr. Moser	Air Conditioning and Refrigeration Institute	703-524-8800
	Nick LaCourte	American Society of Heating, Refrigeration and Air Conditioning Engineers	212-644-7946
	John Sherry	National Fire Protection Association	617-482-8755
	R. Bauer	American Society for Testing Materials	215-299-5406
	Joe Crossly	American National Standards Institute	212-868-1220
	Mr. Reynolds	American Society of Mechanical Engineers	212-644-7722
	Frank Hodgdon	American Gas Association	216-524-4990
	John Eberhard	American Institute of Architects	202-785-7808
	Paul Smith	American Gas Association	703-524-2000
	Chuck Shram	Underwriter's Laboratories	312-642-6969
	Andrew Sabhlok	National Association of Home Builders	415-548-1057
	Larry Ellis	National Association of Home Builders	202-452-0362
	Don Leubs	National Association of Home Builders	202-762-4200
	Don Corrigan	American Insurance Association	202-293-2440
	Mr. Gilmore	American Insurance Association	
	Pauline B. Dunkel	Energy Research Council	301-229-2549
	Mr. Ryan	Pittsburg Testing Laboratories	412-922-4006
Consumer Groups	Dr. F.J. Schlink	Consumer's Research Inc.	201-689-3300
	Nonte Florman	Consumer's Union	914-664-6400
	Sarah Newman	National Consumer League	202-347-3653
Finance	Roger McCallister	Equitable Trust	301-547-4239
	Herbert Williams	Percentile Safe Deposit Trust	301-237-5366
	Harold Olin	U.S. Savings Loan League	202-376-3282
	D.O. Wipf	Perpetual Federal Savings	202-783-7700
Utility	Jerry Table	Michigan Consolidated Gas Company	313-965-2430
	John Turko	Michigan Consolidated Gas Company	313-965-2430
	Gordon Hill	Union Gas Ltd.	

APPENDIX C - CASE STUDIES

The product case studies presented in this section are representative of energy saving products used in residential buildings having encountered market restrictions connected with certification or listing practices. Each case presented is unique in that a different set of associated circumstances have contributed to reducing the products market penetration. Yet, these products are similar in that major marketing problems have arisen, which are to some degree attributable to obtaining certification or listing.

CASE STUDY

CONTACT: Robert F. Albrecht
INDUSTRY: Trionic Industries, Inc.
PRODUCT: Automatic Flue Gas Damper

SUBJECT: The automatic flue dampers are operated by either natural gas or propane fuel. When installed in the vent pipe of a home furnace the device automatically prevents thermal and vacuum updrafts from escaping through the open vent pipe, thus venting the furnace while in an operating mode and preventing heat loss when the burner is out. Tests and reports have shown that home energy savings range from six percent to 30 percent when the damper is in use. Originally this equipment was designed to be utilized as a retrofit item that could be installed on existing furnaces.

Automatic damper manufacturers have attempted to market this product, but have encountered market restrictions. As with many furnaces or boilers used in residential structures, local code jurisdictions have mandated that various equipment must carry the labels of nationally recognized certifying institutions to demonstrate safety. The automated stack damper (first certification attempts made in 1968) cannot obtain such certification for no standards exist by which to develop certifying tests for the damper. The major problem restricting this product's market entrance is in developing a standard to test the device as a retrofit item to a gas fired furnace.

In 1968, the damper was introduced to the AGA to obtain certification. An AGA listed certifying laboratory conducted several tests on the product and found few design and utilization problems, but the tests conducted were not for certification due to the fact that no standard existed which could be utilized to test the product. A need then arose to develop a standard. Since the device would be primarily used on gas furnaces and operated by electrical current, UL and AGA certification was required by local code officials. Both of these certifying institutions are currently participating on the American National Standards Institute's ANSI-Z21 committee (body designated to set the procedures for new standards development). The Z21 Committee, "ANSI Committee on Performance and Installation of Gas-Burning Appliances and Related Accessories," was assigned to develop a standard for the stack damper. Between 1970 and 1976, the following committee events have been recorded concerning standards development activities for the stack dampers:

February 1970: The subject of automatic dampers was first discussed by the Z21 Committee at its February 1970 meeting, at which time the Committee questioned the safety aspects of field installing automatic dampers on gas appliances since any malfunction due to misinstallation could result in the flue gases venting into the occupied living space.

March 1971: The subject was again brought up at the March 1971 meeting, and a manufacturer of one of the damper devices made a presentation to the Committee demonstrating a working model of his device. The Committee unanimously agreed to form a study group to evaluate the need for standards for automatic dampers.

April 1972-73: The subject was again presented at the April 1972 meeting of the Z21 Committee and after extended discussion, a task force was set up to continue the consideration of the field performance of flue dampers and to proceed to develop a standard that would cover their construction, performance and proper installation if the task force should decide that an automatic damper standard was warranted. The task force reported back to the Z21 Committee at its April 1973 meeting that the known field performance with automatic dampers being prepared in draft form.

April 1974: The entire subject of automatic dampers was thoroughly discussed at the April 1974 meeting of the Z21 Committee. The automatic damper previously demonstrated to the Committee and a thermally actuated damper were both demonstrated to the Committee. The Committee was informed that the proposed "American National Standard for Automatic Vent Damper Devices for Use with Gas-Fired Appliances," submitted to the Committee by letter ballot in December 1973, had been rejected (16 approved, 23 disapproved, and 2 not voting). The disapproving votes were primarily based on the safety aspects of the field installation of these devices. Among the reasons stated were the possibilities of improper installation, misapplication to the appliance control system, condensation and resultant corrosion of the venting system, and leakage of unburned gas. In view of the unfavorable vote, the unanimous decision of the Committee members present was that, based on safety considerations, the standard for automatic dampers to be field installed on existing gas appliances should not be approved; but, rather, the standards for warm air heating furnaces and boilers should be augmented with requirements for testing such appliances when factory equipped with automatic dampers.

April 1975: A progress report presented at the April 1975 meeting of the 221 Committee indicated that the Warm Air Furnace and Boiler Subcommittees had complied with the Committee's directive to include coverage for automatic vent damper devices in furnace and boiler standards, but the standard did not cover the installation of the damper as a retrofit item.

March 1976: Hearings were conducted before the Senate Subcommittee on Antitrust and Monopoly concerning the question of "how the voluntary standard programs can thwart competition in the marketplace." The flue gas damper was presented as a case for the committee to explore the affects on competition of standards development.

June 1976: During this month, two documents were published concerning the damper and standards development. The first was John Muller's paper on "The Automatic Flue Gas Damper and Its Potential for Reducing the Nations Consumption of Oil and Gas," providing a summary of ANSI's actions and further illuminates the safety considerations associated with utilizing the product.

A paper titled "Evaluation of Alternatives for Conserving Fuel Resources," was presented by the Institute of Gas Technology to the 13th World Gas Conference held in London. The paper concluded that flue dampers increase seasonal efficiencies, yet, similar savings may be obtained through improved vent and chimney sizing and sealed-combustion systems.

Recently other papers and studies are being prepared, for example: Michigan Consolidated Gas Company is currently performing studies to determine which products will achieve energy savings when retrofitted to existing furnaces. The damper is one of the devices being tested. But at this time no standard exists by which to test the stack damper as a retrofit item. Manufacturers such as Trionics Industries, have achieved some success in marketing their product on oil fired furnaces, but the gas furnace market is virtually closed without AGA and UL certification.

CASE STUDY

CONTACT: David P. Hart

INDUSTRY: Janitrol Division/Andro Corporation

PRODUCT: Heat-only heat pump

SUBJECT: The unitary heat pump is a device which is used only for heating purposes in the home. The indoor portion of the system consists of a compressor, a condenser coil, and all electrical and refrigerant flow controls. The outdoor portion consists of the evaporator and evaporator fan and motor. Indoor air moving is provided by any type of furnace available; oil or natural or propane gas. The furnace will be used for air moving primarily with a secondary function of providing backup heat should heating requirements exceed the heat pump capacity at low outdoor temperatures.

The reasons the heat-only concept is more efficient than a conventional reversing cycle system are listed below:

- (1) The reversing valve in a conventional system causes losses in the form of cooling the discharge fluid by heat transfer outdoors and by high to low pressure leakage. The Janitrol system doesn't have a reversing valve.
- (2) Conventional reversing cycle systems have the compressor outdoors because cooling efficiency would suffer excessively if the compressor were indoors, but the compressor is warmer than outdoor ambient; therefore, heat is lost through the compressor shell. The heat-only heat pump has the compressor indoors, eliminating this heat loss.
- (3) Discharge lines and liquid lines to and from the indoor coil of the conventional system go out of the conditioned space where they lose heat to the outdoors. These lines are in the indoor air stream on the heat-only system.
- (4) The heat-only heat pump has the expansion valve inside the indoor unit; therefore, both connecting lines will be at low temperatures. Any heat added to these lines outdoors affects the system as extra evaporator area giving a net gain in capacity.

- (5) Both indoor and outdoor coils are oversized to the point that the owner can use a much smaller compressor than is standard for a given size of reverse cycle heat pump; thus achieving the same heating capacity at less compressor wattage.

Due to these basic design differences between the Janitrol prototype and conventional reverse cycle heat pumps, the Janitrol heat pump will operate at good efficiencies as the outdoor temperature drops below zero degrees Fahrenheit.

The product may be used for residential heating, in which case homeowners would purchase it through a HVAC contractor. The product may also be used for commercial or industrial heating or heat reclaim, in which case, a building owner or manager would be the end purchaser. For the purposes of this study, the concern is in utilization of this product for residences.

The Janitrol product has encountered some marketing restrictions attributable to certification practices, due to the fact that most metropolitan areas require Underwriters Laboratories or Air Conditioning and Refrigeration Institute approval, or approval of the city authorities. Many city chief inspectors will not approve the heat-only heat pump without UL or ARI approval. The reason being that UL or ARI approval assures communities that a certified product is safe for the use it was intended. There does not exist a UL or ARI standard which would include improving the heat efficiency for homes utilizing an already existing electric furnace. UL requires that the existing electric furnace be removed and a "matched system" installed, thus, the entire system would be tested by existing standards. Secondary market restrictions have arisen due to the fact that a standard does not exist. Janitrol lacks the money and time to await standards development. In the words of Mr. David Hart, Chief of Engineering/Cooling Products "To go through the procedure required to have UL standards written to include the Janitrol product is beyond capital, personnel, and time resources of this corporation." Janitrol only envisions two options to obtain certification: (1) to test the product on Janitrol furnaces as a total package, thus requiring that the existing furnace be scrapped and the Janitrol unit installed, and/or, (2) to submit the product to be tested for use with any furnace; thus, creating a need for standard development. The first alternative costs approximately \$15,000 for Janitrol engineering testing, paperwork, models, and direct testing and standards fees as designated by the certifying agent. Similar costs attributable to the second alternative would be approximately \$50,000 in order to complete the process.

At this time, Janitrol is seeking additional funding from the Energy Research and Development Administration in order to follow one or both alternatives. Actions taken by Janitrol to date have been identified below:

November 1974: At the request of the Government Relations Committee Subcommittee, ARI staff analyzed the unitary heat pump listings in the current issue of the Unitary Certification Directory for units having a standard rating cooling capacity of 42,000 Btuh and below. Coefficients of performance of standard rating conditions, both heating and cooling, were calculated from data in the directory. The coefficient of performance at the application rating (heating) was calculated from the capacity given in the directory and certification data submitted to ARI by companies which participate in the program. These coefficients of performance were then compared to the criteria in the draft specification and were evaluated on a go/no-go basis.

The analysis had shown that there are no air-source heat pumps listed which have a standard rating cooling capacity of less than 29,000 Btuh and which comply in all respects to the COP criteria of a proposed Department of Defence specification. This caused some concern, for assurance had been given by those who had proposed the criteria that there would be at least three, and in most cases four, companies which could supply equipment which complied with the specification in each of the capacity ranges.

June 1975: Janitrol submitted an unsolicited proposal to the Energy Research and Development Administration for financial assistance on obtaining certification of their product. Thus, Janitrol will continue to seek funding and the certification of the heat-only heat pump as long as it is financially feasible.

CASE STUDY

CONTACT: Melvin H. Sachs

INDUSTRY: U-Form Systems and Technology, Inc.

PRODUCT: Permanent Pre-Insulated Pre-Veneered Integrated
Wall Forms for Reinforced Concrete Construction

SUBJECT: The "U-FORM" (registered trademark) System makes use of plant fabricated permanent forms for use in the construction of reinforced concrete walls. "U-FORMS" are modular units that may vary in size and shape depending on physical requirements of the project and limitations of the fabricating equipment. Typical dimensions of U-Forms are one full story (9' to 12') high by 10" - 12" thick by 8' or 15' long. Erection of U-Forms, insertion of reinforcement in vertical and horizontal voids, and casting of concrete in voids provide an integral, continuous reinforced concrete structural wall system. The U-Forms remain in place to provide thermal and acoustical insulation and vapor resistance. They may contain furring strips for attachment of various appurtenances such as windows, door bucks, cabinets and interior surfacing materials. U-Forms for use in exterior walls may also be pre-finished on the exterior walls with a suitable veneer. Interior veneers and electrical wiring may also be factory installed.

This product is designed to be used in many different types of structures from sophisticated high rise commercial and residential buildings to low rise multiple dwellings. The development of U-Form has been the result of a ten year effort of intensive research and development. During this period of time the manufacturers of U-Form have encountered market restrictions from local building code officials who would not issue a building permit for a building using polyurethane, the original insulation component. Below is a brief historical sketch of the product's certification and listings as well as standards met and difficulties with building code officials will be presented:

May 1967: Detroit Testing Laboratory had shown that the strength of concrete poured into U-Forms was higher than that of the ASTM Cured Cylinders in every case.

April 1971: Compression tests of concrete wall structure formed in U-Form wall were conducted by Detroit Testing Laboratory with favorable results.

September 1971: Racking tests were conducted by Cement and Concrete Research Institute, Division of Portland Cement Association with favorable results.

November 1971: Johns-Manville Research and Engineering Center conducted freeze-thaw tests exhibiting no failures of any kind.

March 1972: Detroit Edison Company conducted comparative analysis of heating and cooling demonstrating that U-Forms saved approximately one-third of the total yearly energy cost requirements, as compared to conventional construction methods.

April 1972: Southwest Research Institute Laboratories conducted modified ASTM E-84 tests for flame spread and toxicity. Modification entailed running the tests nine times longer than required by ASTM. Specimens passed test conclusively with flame spread 25 or less, low smoke and no toxicity.

October 1974: Pittsburg Testing Laboratories certified that U-Form was in compliance with ASTM E-119 fire tests. One specimen ran 5 hours 20 minutes before failure and the other almost 7 hours.

April 1975: Cement and Concrete Research Institute, Division of Portland Cement Association confirmed that new configuration (story high) of U-Form structural performance was in excess of the American Concrete Institute Building Code requirements for racking and compression.

June 1975: Building code approvals were withdrawn for U-Form due to a general construction industry controversy over the use of foamed plastics and fire safety which necessitated redesign of the product.

June 1975: U-Form was then redesigned to include a one and one-half inch mineral based rigid foamed glass with a foamed polyurethane core (with voides for C.I.T. concrete structure). The product met with building regulations in the Detroit, Michigan area, and was to be published in the Department of Housing and Urban Development's Structural Engineering Bulletin. U-Form in this form was tested for and met ASTM fire standards E-119 and flame spread tests.

December 1975: A building permit was to be issued in the Detroit area for U-Form in its redesign state. But, during this time a fire involving polyurethane walls in a building under construction in Chicago occurred. On the basis of that fire and without investigation or documentation, building officials once again refused to issue a building permit for U-Form. Also, the HUD bulletin was not issued as a result.

January-February 1976: Once again, the product U-Form was redesigned to include any suitable sheet material on the exterior with one-half inch type gypsum board on the interior, and a core consisting of a non-combustible glass fiber, mineral wool or treated cellulose insulation with voids for cast in place concrete structures. The product in this form met with applicable ASTM fire standards and was found acceptable to building regulations in the Detroit area. Further, the HUD revised and issued the Structural Engineering Bulletin No. 869 on June 14, 1976. A building was built using the redesigned U-Form product.

What is demonstrated in this case study is that although a product meets product certification or listings or recognized building codes, the local code official can unilaterally restrict products from coming to the marketplace by not issuing a building permit. This action may continue as long as the building official remains unsatisfied concerning the safety, construction, or reliability of the product. Thus, a product may be restricted from penetrating into various markets due to the final formal evaluator - the building code official - who issues permits for new constructions.

APPENDIX D - PRODUCT ANALYSIS TABLES

Demographic and energy use data developed for the energy and economic analyses of conservation products; and the results of those analyses, are presented in the following tables.

TABLE D-1. REGIONAL HOUSING BREAKDOWN 1970-1990

10⁶ Units

REGION	1970	1976	1980	1990
NORTH EAST AND GREAT LAKES				
Single-Family	10.35	11.2	12.04	13.76
Town House	4.97	5.38	5.78	6.61
Low-Rise	3.11	3.37	3.62	4.13
High-Rise	0.78	0.85	0.91	1.04
NORTH CENTRAL AND NORTH WEST				
Single-Family	11.49	12.57	13.62	16.06
Town House	2.24	2.48	2.65	3.13
Low-Rise	1.78	1.95	2.11	2.49
High-Rise	0.44	0.48	0.52	0.61
SOUTH WEST				
Single-Family	5.73	6.55	7.42	8.95
Town House	0.93	1.06	1.2	1.45
Low-Rise	1.10	1.27	1.44	1.74
High-Rise	0.28	0.32	0.36	0.43
SOUTH EAST				
Single-Family	8.07	8.97	9.99	11.63
Town House	1.10	1.23	1.36	1.58
Low-Rise	0.61	0.68	0.76	0.88
High-Rise	0.16	0.18	0.20	0.23
EAST CENTRAL				
Single-Family	6.6	7.4	8.12	9.55
Town House	0.96	1.08	1.18	1.39
Low-Rise	0.57	0.64	0.70	0.83
High-Rise	0.15	0.16	0.18	0.21

TABLE D- 2. REGIONAL HEATING AND COOLING LOAD DATA

REGION	UNIT HEATING LOAD (THERMS)	UNIT COOLING LOAD (THERMS)	NUMBER OF UNITS ($\times 10^6$)	TOTAL REGIONAL HEATING LOAD ($\times 10^9$ THERMS)	TOTAL REGIONAL COOLING LOAD ($\times 10^9$ THERMS)
NORTH EAST AND GREAT LAKES				15.48	2.05
1. Single-Family	1125	91	10.35		
2. Town House	583	99	4.97		
3. Low-Rise	268	155	3.11		
4. High-Rise	150	174	0.78		
NORTH CENTRAL AND NORTH WEST				14.58	2.78
1. Single-Family	1139	178	11.50		
2. Town House	146	177	2.24		
3. Low-Rise	26	145	1.75		
4. High-Rise	227	185	0.44		
SOUTH WEST				2.83	2.78
1. Single-Family	454	360	5.75		
2. Town House	146	291	0.93		
3. Low-Rise	26	222	1.15		
4. High-Rise	227	212	0.25		
SOUTH EAST				3.21	5.26
1. Single-Family	352	574	8.07		
2. Town House	259	401	1.10		
3. Low-Rise	130	293	0.49		
4. High-Rise	214	379	0.13		
EAST CENTRAL				5.34	2.30
1. Single-Family	710	282	6.59		
2. Town House	492	343	0.96		
3. Low-Rise	291	154	0.57		
4. High-Rise	134	172	0.15		

TABLE D-3. REGIONAL HEATING LOAD-UTILITY SALES CORRELATION

REGION	HEATING LOAD (10 ⁹ THERM)	COMPOSITE REGIONAL EFFICIENCY	PRIMARY ENERGY REQUIREMENT (10 ⁹ THERM)	UTILITY SALES PRIMARY ENERGY REQUIREMENT (10 ⁹ THERM)	CORRELATION FACTOR*
NORTH EAST AND GREAT LAKES	15.48	0.69	22.4	25.9	0.135
NORTH CENTRAL AND NORTH WEST	14.58	0.675	21.6	22.0	0.018
SOUTHWEST	2.83	0.65	4.35	6.35	0.314
SOUTHEAST	3.21	0.63	5.10	7.60	0.329
EAST CENTRAL	5.34	0.62	8.61	8.58	-0.003

* Correlation Factor = $\frac{\text{Utility Sales Figure} - \text{Primary Energy Requirement}}{\text{Utility Sales Figure}}$

TABLE D-4. FLUE GAS DAMPER ECONOMICS

Baseline	Initial Cost (Dollars)	Savings Per Unit (Percent)	Baseline Energy Use Per Unit (Therms)	Net Savings Per Unit (Therms)	Fuel Price (\$/Therm)	Dollar Savings	Product Life (Years)	Cost Effectiveness	Payback Period (Years)
North East and Great Lakes	\$175	15	SF 1610	242	0.288	70	15	2.04	4
			TH 835	125		36		0.56	7
North Central and North West	\$175	15	SF 1630	245	0.223	55	15	1.39	5
			TH 640	96		21		--	--
South West	\$175	15	SF 649	97	0.224	22	20	0.08	12
			TH 209	31		7		--	--
South East	\$175	15	SF 503	75	0.210	16	20	--	--
			TH 370	56		12		--	--
East Central	\$175	15	SF 1015	152	0.212	32	18	0.51	9
			TH 705	106		22		0.04	17

TABLE D-5. FLUE GAS DAMPER ENERGY SAVINGS

Region	Capture Potential 10 ⁶	Market Penetration With Barrier (Percent)	Regional Primary Energy Savings (10 ⁶ Therms)			Market Penetration With Barrier Removed (Percent)	Regional Primary Energy Savings With Barrier Removed (10 ⁶ Therms)			Net Regional Primary Energy Savings Due to Barrier Removal (10 ⁶ Therms)		
			1976	1980	1990							
North East and Great Lakes	SF 9.92	0.0	-	-	-	5.2	125	1,875	15,000	125	1,875	15,000
	TH 4.88	0.0	-	-	-	1.2	7	105	840	7	105	840
North Central and North West	SF 11.22	0.0	-	-	-	3.4	93	1,395	11,160	93	1,395	11,160
	TH 2.14	0.0	-	-	-	0.0	-	-	-	-	-	-
East Central	SF 4.59	0.0	-	-	-	0.9	6	90	720	6	90	720
	TH 0.69	0.0	-	-	-	0.0	-	-	-	-	-	-

TABLE D-6. HEAT-ONLY HEAT PUMP ECONOMICS

Region	Initial Cost	Savings Per Unit (Percent)	Baseline Consumption Per Unit (Therms)	Net Savings Per Unit (Therms)	Fuel Price \$/Therm	Dollar Savings	Product Life (Years)	Cost Effectiveness	Payback Period (Years)
North East and Great-Lakes	700	35	1,125	393	1.38	542	15	4.88	2
			583	204		281		2.05	4
North Central and North West	700	35	1,139	399	0.91	363	15	2.9	3
			447	156		142		0.54	8
East Central	700	40	710	284	1.48	420	15	3.56	2
			492	197		292		2.17	3

TABLE D-7. HEAT-ONLY HEAT PUMP ENERGY SAVINGS

Region	Capture Potential 10 ⁶	Annual Market Penetration with Barrier (Percent).	Regional Primary Energy Savings With Barrier (10 ⁶ Therms)			Annual Market Penetration With Barrier Removed (Percent)	Regional Primary Energy Savings with Barrier Removed (10 ⁶ Therms)			Net Regional Primary Energy Savings Due To Barrier Removal (10 ⁶ Therms)		
			1976	1980	1990		1976	1980	1990	1976	1980	1990
Northeast and Great Lakes	0.61	0.0	0.0	0.0	0.0	4.2	53	795	6,360	53	795	6,360
	0.26	0.0	0.0	0.0	0.0	1.8	12	180	1,440	12	180	1,440
North Central and North West	0.62	0.0	0.0	0.0	0.0	2.7	35	525	4,200	35	525	4,200
	0.13	0.0	0.0	0.0	0.0	0.4	2	30	240	2	30	240
East Central	0.81	0.0	0.0	0.0	0.0	3.3	30	450	3,600	30	450	3,600
	0.24	0.0	0.0	0.0	0.0	2.0	13	195	1,560	13	195	1,560

TABLE D-8. INSTANTANEOUS WATER HEATER ECONOMICS

Application	Differential Cost (\$)	Savings Per Unit (%)	Baseline Consumption Per Unit (Therms)	Net Savings Per Unit (Therms)	Fuel Price \$/Therm	Dollar Savings (\$)	Product Life (Years)	Cost Effect	Payback Period (Years)
Retrofit	100	25	150	37.5	0.88	33	10	1.02	5
NEW Houses	37	25	150	37.5	0.88	33	10	.00	0

TABLE D-9 . INSTANTANEOUS WATER HEATER ENERGY SAVINGS

Application	Capture Potential 10 ⁶	Market Penetration With Barrier (Percent)	Regional Energy Primary Savings (10 ⁶ Therms)			Market Penetration With Barrier Removed (Percent)	Regional Primary Energy Savings With Barrier Removed (10 ⁶ Therms)			Net Regional Primary Energy Savings Due To Barrier Removal (10 ⁶ Therms)		
			1976	1980	1990		1976	1980	1990			
Retrofit	27.8	0.25	25	375	3000	3	101	1515	12,120	76	1140	9,120
New Houses	2.2	12.0	32	480	3840	47	125	1875	15,000	93	1395	11,160

TABLE D-10. FLUE GAS HEAT RECOVERY DEVICE ECONOMICS

Region	Initial Cost (Dollars)	Savings Per Unit (Percent)	Baseline Energy Use Per Unit (Therms)	Net Savings Per Unit (Therms)	Fuel Price (\$/Therm)	Dollar Savings Per Unit	Product Life (Years)	Cost Effectiveness	Payback Period (Years)
North East and Great Lakes	100	8	1,610	129	0.268	37	15	1.8	4
			835	67		19		0.44	8
			385	31		9		-	-
			215	17		5		-	-
North Central and North West	100	8	1,630	130	0.223	29	15	1.2	5
			640	51		11		-	-
			190	15		3		-	-
			480	38		8		-	-
East Central	100	8	1,015	81	0.212	17	17	0.36	10
			705	56		12		-	-
			415	33		7		-	-
			190	15		3		-	-

TABLE D-11. FLUE GAS HEAT RECOVERY DEVICE ENERGY SAVINGS

Region	Capture Potential 10^6	Market Penetration With Barrier (Percent)	Regional Energy Savings With Barrier (Therms) 10^6			Market Penetration With Barrier Removed (Percent)	Regional Energy Savings With Barrier Removed (10^6 Therm)			Net Savings Due to Barrier Removal (10^6 Therm)		
			1976	1980	1990		1976	1980	1990	1976	1980	1990
North East and Great Lakes	9.92	0.53	6.8	102	816	5.3	68	1020	8160	61	918	7340
	4.88	0.11	0.36	5.4	43.2	1.1	3.6	54	432	3.2	49	389
North Central and North West	11.22	0.35	5.1	77	612	3.5	51	770	6120	46	693	5508
	-	-	-	-	-	-	-	-	-	-	-	-
East Central	4.59	0.00	0.0	0.0	0.0	0.07	0.26	4	31	0.26	4	31
	-	-	-	-	-	-	-	-	-	-	-	-

TABLE D-12. INFRARED SPACE HEATER ECONOMICS

Region	Initial Cost (Dollars)	Savings Per Unit (Percent)	Baseline Energy Use Per Unit (Therms)	Net Savings Per Unit (Therms)	Fuel Price (\$/Therm)	Dollar Savings Per Unit	Products Life (Years)	Cost Effective-ness	Payback Period (Years)
North East and Great Lakes	100	8	1125	90	1.38	124	15	8.40	1
			583	47		65		3.94	2
			268	21		29		1.20	5
			150	12		17		0.29	10
North Central and North West	100	8	1139	91	0.91	82	15	5.23	2
			447	36		33		1.51	4
			132	11		10		--	--
			337	27		25		0.90	6
East Central	100	8	710	57	1.48	84	15	5.38	2
			492	39		58		3.41	3
			291	23		34		1.58	5
			134	11		16		1.21	11

TABLE D-13. INFRARED SPACE HEATER ENERGY SAVINGS

Region	Capture Potential 10 ⁶	Market Penetration (Percent)	Regional Primary Energy Savings (10 ⁶ Therms)
North East and Great Lakes	1.83	13	69
	0.78	7	8
North Central and North West	1.86	9	49
	0.39	3	1
East Central	2.43	9	40
	0.72	6	5

TABLE D-14. URETHANE INSULATION ECONOMICS

Region	Initial Cost	Base Unit Loads Therms Per Unit	Composite Regional Efficiencies	Base Unit Energy Use Therms Per Unit	Reduced Unit Energy Use Without Barrier	Net Savings Per Unit (Therms)	1976 Fuel Price \$/Therm	Annual Dollar Savings	Cost Effectiveness	Payback Period
North East North East and Great Lakes	0	268	0.69	388	2%	7.8	1.38	10.8	0	0
North Central and North West	0	132	0.675	196	2%	3.9	0.91	3.5	0	0
East Central	0	291	0.62	469	2%	9.4	1.48	13.9	0	0

TABLE D-15. URETHANE INSULATION ENERGY SAVINGS

Region	1976 Low Rise Multi- Family Stacks (Million Dwelling Units)	1976 Growth Rate	Market Penetra- tion Rate	Net Savings Due To Barrier Removal Quad		
				1976	1980	1990
Northeast and Great Lakes	3.11	10%	5%	0.000012	0.000181	0.00145
North Central and North West	1.75	10%	5%	0.000003	0.000052	0.000412
East Central	0.57	10%	3%	0.000002	0.000024	0.000193

TABLE D-16. NET ENERGY SAVINGS COMPARISON QUADS

Product	1976 Net National Savings	1980 Net National Savings	1990 Net National Savings	1976-1990 Residential Energy Use ¹	1976-1990 Percent Reduction
Flue Gas Damper	0.0231	0.347	2.77	297.0	0.93
Heat-Only Heat Pump	0.0145	0.218	1.74	297.0	0.59
Instantaneous Water Heater	0.0169	0.254	2.03	297.0	0.68
Flue Heat Recovery Device	0.0110	0.166	1.33	297.0	0.46
Infrared Space Heater	0.0172	0.0172	0.0172	297.0	0.006
Urethane Insulation	0.000017	0.00025	0.002	297.0	negligible

¹Based on an average of high and low projections in Projections of Energy Availability, Cost, And Aggregate Demand For 1975, 1980, 1985, and 1990, Hittman Associates, Inc., Prepared for the U.S. Army, July 1978.

APPENDIX E - HAI WORKSHOP ON BARRIERS

A workshop was held on November 18, 1976, at the HAI facilities in Columbia, Maryland, to examine institutional barriers which inhibit energy-conserving products from reaching the marketplace.

The objective of the workshop was to identify policy or program options whose implementation would increase the rate and degree of market penetration of energy conserving products where the market penetration is now restricted by certifying or listing practices and procedures. In order to develop practical policy options, we (HAI) believed that it was absolutely necessary to take into account the opinions of those individuals and organizations who would be directly affected by changes in certifying and listing practices and procedures. Accordingly, we invited fourteen representatives from manufacturing, certifying, governmental, financial, building code, and academic organizations to participate in this workshop. A list of the workshop participants follows this discussion. With their collective expertise and assistance, we were able to:

- identify institutional barriers affecting the market penetration of energy-conserving consumer products used in homes;
- rank these barriers as to their relative importance; and
- identify several practical and workable policy/program options whose implementation would mitigate the barriers identified.

It is important to point out that the following summary of the workshop is strictly the interpretation of the project by HAI and its subcontractor, Building Technology, Inc. The specific concurrence of particular participants in the conclusions of the workshop or this project should not be inferred from this discussion.

It appears to the project team that of all of the possible barriers discussed, the following are the most significant (in descending order of importance):

- lack of an information source on how to use the certifying system (from the manufacturers' and financial organizations' viewpoints),
- a limited number of nationally recognized testing laboratories,

- costs of testing,
- absence of performance criteria,
- product liability (from manufacturers', financial organizations', and certifying agencies' viewpoints),
- length of time required for certification,
- too many codes, and
- local politics.

These barriers relate to manufacturers unless otherwise noted. Some of the mitigating solutions suggested for the above barriers were:

- coordinate and make better use of existing information sources,
- subsidize the costly (to the manufacturer of a novel device) development of standards associated with the testing and certification of a novel (first time through) energy-conserving device or structure,
- increase the financial support to NIBS and other standards development organizations; encourage these groups to eliminate overlapping standards,
- develop legislation to limit the product liability of a manufacturer, certifying laboratory, or financial institution,
- increase the number of testing and certifying laboratories by a national accreditation program and other means,
- encourage model code groups and encourage states to terminate local code options,
- encourage the development of uniform performance codes and a system of material/ product acceptance products,
- develop legislation to limit the liability of local code enforcement officials, and
- develop certification programs (and associated training programs) for local code enforcement officials.

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WORKSHOP ON BARRIERS CONNECTED WITH CERTIFYING OR LISTING PRACTICES

November 18, 1976

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APPENDIX F - MICHIGAN CONSOLIDATED WORKSHOP

On October 15, 1976, a workshop was held at Michigan Consolidated Gas Company in Detroit, Michigan, to discuss Michigan Consolidated's furnace testing program, which included the testing of five energy-saving furnace devices. Michigan Consolidated had hoped to devise ways in which their customers could remain comfortable in their homes while using less gas for heating. A brief description of the sequence of events and their impact follows.

In the summer of 1975, Michigan Consolidated embarked on a test project to determine the effectiveness of several different devices designed to improve the efficiency of furnaces and to reduce heat loss through furnace chimneys. Initially, they conducted theoretical studies of heat loss and energy waste on hypothetical heating systems. Michigan Consolidated determined that significant amounts of warm air were lost through flues and up oversized chimneys. They also concluded that furnaces were not operating as efficiently as possible since the furnaces tended to be oversized for the homes they heated.

Five products were tested to identify which had the best energy saving capability at the lowest cost. The five devices were:

1. Flue Gas Damper
2. Reduced Burner Orifice
3. Two Stage Gas Supply Valve
4. Flue Restrictor
5. Electronic Ignition

These devices were tested in single, double, and triple combinations, and all five together. The test results indicated that the flue restrictor and reduced orifice combination was the most cost effective and achieved considerable energy savings.

The Michigan Consolidated's tests were significant in three respects. First of all, during the tests of these five products, it was found that codes played a significant role in restricting the retrofitting of furnaces in Detroit homes. In order for Michigan Consolidated to test the energy efficiencies of the five products, they needed to monitor them in actual situations. Detroit code officials and insurance companies refused to allow products to be installed on furnaces unless the products had attained certification from the proper certifying authority. The

flue gas damper did not have certification and initially was prohibited from being installed. Local code officials finally permitted the damper to be installed for testing purposes if the furnace was restored to its original condition upon completion of the tests.

Second, manufacturers of flue gas dampers have been trying to obtain certification for their product from the American Gas Association for at least the last seven years. The Michigan Consolidated study pointed out that there are safety problems involved in installing the flue gas damper.

The study also concluded that the damper did not save as much energy as some of the other products, which the manufacturers of the flue gas dampers dispute.

Third, the study pointed out that local codes and standards are antiquated in some cases. For example, the oversizing of chimneys in the Detroit area results from conformance with local building codes and specifications that were adopted when most homes were heated by coal-fired furnaces. Codes specified large chimneys and flues to provide better combustion of coal while assuring strong drafts to eliminate soot buildup. These codes obviously need revising.

The Michigan Consolidated study is important in that it shows the impacts that the utilities can have on conservation, certification, and codes.