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INSTITUTIONAL ANALYSIS OF STANDARD SETTING
IN THE UNITED STATES: A PRELIMINARY EXPLORATION

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ABSTRACT

This paper, one of a series resulting from institutional analysis of photovoltaic (PV) acceptance, discusses standards and the standard setting process in the United States. Standards, and the manner in which standards are established, can play a significant role in facilitating or impeding the acceptance of solar technologies. The objective of this paper is to provide an overview of standards for those concerned with ensuring the timely and appropriate acceptance of needed new energy sources in diverse economic and geographic sectors. The paper has three sections. The first provides a conceptual framework for understanding standards. The second section discusses a number of approaches for categorizing standards. Finally, the third section identifies the processes employed and the persons and organizations involved in the standards development process in the US.

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INTRODUCTION

The pages of this paper are numbered consecutively; the sentences are read from left to right and from the top of the page to the bottom; each sentence begins with a capital letter and concludes with a period or other punctuation mark.

These five conventions all represent standards: they are acknowledged if not agreed on terms and practices and provide at least a basis for comparison if not for use. This paper is, in fact, only readable and comprehensible at all because it is a collection of symbols that have standard definitions (commonly called the English language). Similarly, it now exists in typed form only because typewriter keyboards have all been standardized to conform to the written symbols in the English alphabet, and because a secretary is trained to use a typewriter with a standard keyboard arrangement.

Standards pertain not only to communication systems, but are fundamental to all areas of social, political and economic life. For example, nearly all physical goods in our economy are produced with reference to standards for materials, design and performance. Our behavior toward one another is governed by a set of standard rules that tell us what modes are appropriate and/or desirable for what given circumstances. Our political system might be viewed as a set of standard rules and procedures for determining the more formal modes and structures for behavior and our legal and judicial systems, respectively, as sets of standard rules for administering and adjudicating them. Finally, our economic system might be viewed as a set of standard rules for the allocation of scarce resources and our financial system, a set of

standard rules for their exchange. That is, the competitive model in which buyers and sellers freely exchange goods and services in the private marketplace is the standard on which the American economic system is founded, and the dollar is the American standard currency.

This listing is, of course, incomplete. Suffice it to say that standards pervade all forms of human activity and affect us constantly. There is a considerable degree of variation among standards. Some are used on a voluntary basis, others are required by law; some apply to products, some to social processes, and some to service procedures. Moreover, there are wide variations in the purposes standards serve -- some assure the compatibility of two distinct products, others reliability and durability in performance. In general though, standards lend an appearance of order and stability to reality; they help to make our world manageable.

This paper on standards is one of several papers providing background for institutional analysis studies of the US housing sector. This and related studies are being sponsored by the US Department of Energy (DOE) as part of its Photovoltaic Program. Housing institutional arena studies are being undertaken in the context of the DOE-HUD Solar Heating and Cooling (SHAC) Demonstration Program. The SHAC demonstration program involves direct federal funding grants to assist project developers to incorporate solar thermal approaches into various building forms. In this context institutional analysis is directed to understanding those forces which influence the rate and nature of solar thermal innovation acceptance in the housing sector. (For a more detailed discussion of the theory of institutional analysis, see Nutt-Powell, *et al.*, 1978.) The other papers are more explicitly housing

linked, considering production, research and socialization, government involvement and energy provision. (See Swetky and Nutt-Powell, 1979; Furlong and Nutt-Powell, 1979; McDaniel and Nutt-Powell, 1978; and Reamer, Heim and Nutt-Powell, 1979.) By comparison this paper discusses standards and the standard setting process. Though providing a general framework for understanding standards, the primary concern is with a specific sub-set of standards, those pertaining to industry and production.

The paper has three sections. The first section provides a conceptual framework for understanding standards. The second section discusses a number of approaches for categorizing standards. Finally, the third section presents the standards development process for industry and production standards. By identifying the processes employed and the persons and organizations involved, this section provides a chronological sense of the standards development process in the US.

A CONCEPTUAL FRAMEWORK FOR 'STANDARDS'

Ironically, there is no general agreement on the definition of a standard; standards, so to speak, have not been 'standardized'. Most often, standards are defined and discussed in the context of a particular standard type. In the industrial sector, for example, the term *standard* is often used synonymously with the term *specification* to denote specific requirements that must be satisfied by physical products and materials. Alternatively, standard is used to define common units of measurement, for example, fixed intervals of time, or finite units of length, weight or mass.

Definitions of this sort are helpful in highlighting the differences among different standard types; however, they tend to obscure or, at the least, understate the common conceptual basis on which all standards are founded. More broadly conceived, standards are defined to include all things accepted for current use (e.g. products, procedures, actions) or things taken as bases for comparison. Acceptance for use can result from authority, habit or custom, or by virtue of general consent. Moreover, standards exist on many different levels; a standard might be applicable to a single individual, an entire society or even to all societies in the world.

Taken from this broader perspective, standards can be viewed as, at a minimum, norms and, where broadly accepted, as institutions. Like norms, they embody society's judgements about the desirability of actions, processes, products and events. Standards are a means of determining whether things are good or bad, superior or inferior, appropriate or inappropriate and so on. Additionally, because such judgements are known and acknowledged, whatever

the level of acceptance may be, they serve as a basis for communication of agreed upon meanings. Thus, goods produced with certain materials or through certain established procedures are commonly thought of as safe and/or reliable. Because they are produced 'according to standards' they are viewed more positively than goods produced through other means. Likewise, certain modes of dress are taken to be 'stylish' or 'functional', while others are seen as 'in bad taste', or 'inappropriate'. These judgements are made based on standards related to clothing, the context, or both.

Thus, whether matters of technical specification or of taste, standards are normative in so far as they carry some prescriptive or proscriptive quality. Admittedly, there is wide variation in the extent to which a standard is mandatory. There are some standards to which we feel we must conform, others we may barely note in passing. Even if a conscious decision is made to ignore a given standard, including one sanctioned by law, the normative quality of the standard remains; one is obliged to evaluate the action (follow/ignore) using the standard as a point of reference.

To take this norm-based definition of standards one step further, it is useful to consider the more encompassing entity, the institution. Institutions traditionally have been differentiated from norms in two ways: (1) the intensity of social sanctions and the degree of consensus with which they are supported and applied; (2) the degree to which they exhibit structure, that is, an appreciable degree of regularity and interrelationship. Institutions have both meaning and form; they embody social meaning and reflect the relative desirability of actions, considered contextually.

A similar distinction can be made with standards. Some standards, are more than norms because they provide a consistent framework for evaluating and resolving recurrent situations. Whether legally sanctioned or enforced by more informal sources of authority, they prompt consistent and prevalent conformity.

Standards of this institutional type are not difficult to find. Consider for example the complex of standardization in the industrial organization. Employees report to work at appointed hours and carry out their work tasks in accordance with pre-established codes of acceptable practice. Materials are handled and processed in accordance with standard practices for technological efficiency, worker safety and performance. Following completion, products will be inspected, coded, inventoried and shipped. In the accounting department, purchase and sales orders and payments are recorded and paychecks distributed, all on schedule. Similarly, in the administration department, personnel training programs are carried out, plant operation reviewed and policy determined. Beneath this formally discernible regularity, there exist more subtle forms of order and predictability -- the workroom rituals or the do's and don'ts in the employee cafeteria, for example. Similar examples of patterned regular behavior can be cited from academic, commercial, retail, or sports settings, indeed, from any form of social and/or economic organization. In all instances, actions, processes and events are carried out with an order and regularity such that we can observe the prevalence and consistency of group standardization.

It is directly from this patterning, this routinization of behavior, that the benefits of standards accrue. Serving as models and codes for behavior

standards make life in human society predictable; they reduce chaos and impose a sense of order and stability on reality. True, there may be negative externalities to such routinization; standards often constrain human behavior in ways that are thought to be excessive and violations of individual freedom. Nonetheless, it is apparent that without some degree of predictability, human society could not exist -- there could be no cooperation, no communication, no sharing of knowledge.

Importantly, then, humans seem to require and naturally pursue standardization. As the anthropologists suggest, humans, in contrast to the animal world, have no species-specific environment, that is, no environment structured by instinctual organization. Thus, while for humans' biological needs and instincts do set a direction and act as constraints, human society must be constructed. The patterning of behavior, through standardization, provides a means for compensating for biological instabilities; it is through such means that humans are able to provide the requisite structure and stability for social conduct. As Berger and Luckmann explain:

Habitualization provides the direction and the specialization of activity that is lacking in man's biological equipment, thus relieving the accumulation of tensions that result from undirected drives. And by providing a stable background in which human activity may proceed with a minimum of decision-making most of the time, it frees energy for such decisions as may be necessary on certain occasions. In other words, the background of habitualized activity opens up a foreground for deliberation and innovation (Berger and Luckmann, 1967, p. 53).

Pursuing this line of reasoning on a less theoretical level, it is important to distinguish among four primary contributions made by standardization. First, as the preceding discussion implies, there are important psychological gains to be achieved. Choices are narrowed and each situation need not be approached anew; the individual is freed from the burden of all those decisions. Because we can predict how others are likely to respond in any given situation, each action need not be a source of astonishment and danger. In this way, standardization helps to stabilize the many separate actions of individuals as well as their interactions with one another.

Concurrent with this psychological gain, standardization makes possible an economic use of human resources. By definition, standardization implies that something has been tried before. As a result, the potentialities and consequences of engaging in a particular course of action are known. An awareness exists regarding the actions needed to accomplish a given objective, implying that the actions may simply be repeated when the result is desired. Consider for example, the architect designing a school building. He/she need not expend undue efforts in researching and testing the strengths and characteristics of the various building materials for use in the design. This information is already available; there exist standard acceptable practices regarding the usage of materials in the construction of school buildings. Similarly, he/she need not write page upon page describing the materials desired for use. Because these have already been categorized, he/she can simply cite a code name for the materials and briefly describe a particular manner of construction for their use. These actions have been cast into patterns, and can be repeated at will with the same economy of effort when such ends are desired.

Using the same example, it is easy to see how standards make possible an economic use of physical resources as well. That is, a manufacturer of building materials, knowing the types and characteristics of materials acceptable for use, will gauge his production decisions accordingly. Quite simply, materials that are not acceptable (that is, not routinely used) will not be produced, except, perhaps, by special order. The more accurately the manufacturer is able to predict the behavior of others (that is, the more routinized the practices in question) the greater the efficiency gains that can be expected. Indeed, nearly all forms of economic organization are made routine precisely for this reason.

Finally, it is important to recognize the general facilitation and communication benefits, perhaps the most basic contribution of standardization. Because actions and behaviors are routinized and because we name them (even if we do not explicitly engage in them) they serve as useful points of reference. In the preceding example, the architect was able to merely name something in a word or two, say 'Steel 160', and others would know exactly what was meant. Alternatively, taking a broader perspective, we might consider that language and all forms of communication are actually forms of standards. Words, pictorial symbols, physical gestures are given common definitions; meaning is retained, i.e. standardized. It is on this very fundamental level that standards help in the construction of a stable and ordered social reality. The world is constantly in flux, yet it is made both comprehensible and manageable because we routinize our behaviors and thereafter 'name' them.

APPROACHES TO CATEGORIZING STANDARDS

There are numerous reasons for and attributes of standards. Even the preceding cursory review reveals the enormous diversity of type, use and impact. In order to make some sense of the nature, use and impact of standards in the housing arena, it is important to develop some manageable categories. This section identifies these approaches to categorizing standards, based on major identifying characteristics. These approaches to categorizing standards are summarized in Table 1, and discussed on the following pages.

Subject/Topic

One beginning point in sorting out the many different attributes of standards is to identify the subject or topical area in which they are found. This might be done along both *sectoral* and *functional* lines. For example, a sectoral view might distinguish standards pertaining to engineering, chemistry, the military, agriculture or transportation. Alternatively, a *functional* approach might distinguish standards pertaining to production, finance, research, service or socialization. Many function-type standards will appear in many sectoral areas, though taking on slightly different forms in each. For example, certain finance related standards will be applicable to both transportation and agriculture, yet both agriculture and transportation will have additional or at least slightly varied financial standards as a consequence of their different sectoral activities.

Aspect

One typology often used to assess standards (whether sectoral or functional)

TABLE 1

APPROACHES TO CATEGORIZING STANDARDS

APPROACH	EXAMPLE
<u>By subject/topic</u>	
Functional	finance, service, research
Sectoral	agriculture, housing, military
<u>By aspect</u>	
Definition	a vacuum cleaner is...
Classification	words naming places, things, ideas are nouns; words describing or qualifying nouns are adjectives
Specification prescriptive	product X may contain no more than 50% water, 30% bone and 20% chemical preservatives, by weight
performance	prison bars must be able to withstand 18,000 cycles of a hacksaw blade
Recommended practice	guidelines for merchandise display
Measurement	econometric method for determining the GNP
<u>By manifestation</u>	
Manner of development natural	a gentleman tips his hat to a lady
formal	Executive Order 12003
Source	ASTM A629, performance standard for prison bars
Enforcement	The fear of hellfire ensures certain behavior by members of many fundamentalist sects.
Purpose quality	FHA's Minimum Property Standards are created to guarantee that publicly insured housing is decent, safe and sanitary.
uniformity	35mm slides and projectors
simplification	reducing paint brush types from 480 to 138
regulatory	Step-rates for electricity use, with a base "life-line" rate

focuses on the aspect of the subject being considered. This five-element typology covers (1) definition, (2) classification, (3) specification, (4) practice and (5) measurement.

Standards relating to nomenclature, creating a common language for a given area of knowledge, are called *definition* standards. Standards of this type are extremely prevalent; in fact, all forms of communication fit into this category. Words, pictorial symbols, gestures and so on are known to embody specific meanings in prespecified circumstances and thereby facilitate information exchange. Similarly, physical materials and products are often defined by their major attributes and thereafter given specific names. The American Society for Testing and Materials (ASTM), for example, defines something as commonplace as a 'vacuum cleaner' ("a system or device that removes material, usually loose, from surfaces by means of the air flow caused by subatmospheric pressure") in order to simplify purchasing procedures.

Second, and in many ways similar to standard definitions, are *classification* standards. These standards divide actions, products, events, processes and so on into different sets or groups on the basis of similar attributes -- for example, physical properties, composition, origin or use. Standards of this type are nearly as prevalent as the first category. In language, for example, we categorize words naming places, things, living beings, ideas and the like as nouns, while words describing or qualifying these nouns are classified adjectives. Similarly, we categorize crimes of a serious nature as felonies and those of lesser severity as misdemeanors.

Third, these can be *specification* standards; that is, they state a specific set of requirements that should (or in some instances, must) be

satisfied by a product, material, process or event. Often, they also indicate the procedure or criteria by which to determine whether the requirements have been satisfied.

A distinction is usually made between two types of specifications, those that are *prescriptive* and those that are *performance-oriented*. Standards of the prescriptive type are more explicit and precise than the latter. Minimum requirements for ingredients in processed foods are of this nature: Product X may contain no more than 50% water, 30% bone and 20% chemical preservatives, by weight. Other examples of prescriptive standards are found in building codes, for example, the requirement that a structure have support columns of a certain thickness (say 2" by 4") at intervals of 16". Performance standards, on the other hand, are not concerned with the particulars but instead state the objective, conditions or criteria which must be satisfied and then describe the tests or evaluations which should be performed to assure that the objectives or conditions are met. For example, the American Society for Testing and Measurement (ASTM) has developed a performance standard for prison bars (ASTM A629) which states that bars must be able to withstand 18,000 cycles of a hacksaw blade. In this case, the composition and diameter of the bars are secondary. Similarly, a performance type standard in a building code would be one stating the stresses and loads a wall must be able to withstand yet omitting the construction methods or materials through which this might be achieved.

A fourth type of standard is the *recommended practice*. Standards of this type are similar to specifications although they are usually service oriented, stating the manner in which some process or procedure should be

carried out. Often, they accompany standard specifications. Many of the various labelling practices in advertising fall into this category. For example, an ASTM Committee on Packaging has developed a recommended practice for the labelling of aerosol cans. Other examples of this type of standard include recommendations for the use and disposal of dangerous materials, guidelines for the installation and operations of machinery and guidelines for merchandise display.

The final aspect to be considered is *measurement*. Standards of this type describe the means of determining the characteristics or attributes of things -- raw materials, finished goods, social conditions. Measurement standards are based first on quantitative dimensions -- physical weights and measures, time, sizes and so on. Secondly, there are standard methods for measuring. For raw materials and commodities, standard test methods are often auxiliary to specifications; they almost always accompany specifications of the performance type. The ASTM, for example, has developed numerous test standards for determining the chemical content in foods as well as methods for sampling and inspections. Similarly, various government bodies, often acting in conjunction with research groups, determine official means for measuring social conditions, for example, the GNP, unemployment or inflation.

Manifestation

First, it is important to distinguish between standards that have developed naturally (through habit, custom or tradition) and those which have been consciously planned. Standards in the former category are often called *natural* standards and include nearly all aspects of culture -- the whole complex of acquired beliefs, morals, customs and habits. Standards in the

latter category are sometimes called *formal* standards; these may be developed in the public sphere through legislative, executive or administrative actions or in the private sphere by standards writing organizations or any group aiming to 'standardize' their activities.

To understand a categorization of standards according to *manifestation*, it is important first to consider the level at which standards development or evolution occurs and the level at which the standards are applicable. Elsewhere we have identified six institutional entities: (Nutt-Powell *et al.*, 1978). These entities -- formal and informal organizations, members, persons, collectivities and social orders -- may be used as a framework for the loci of standards development and use.

Standards may be developed and/or applied at all of these institutional categories. Standards may be developed by one type of institutional entity, may be applicable to another and actually used by still another. For example, the ASTM (a formal organization) may promulgate standards for certain other formal organizations, say, all companies producing X. The standard may be considered relevant for all such companies. Though all may be aware of its existence, only a few companies may actually use the standard. Other companies might band together into an informal organization at the prompting of two company presidents (members) and choose to boycott the standards. The boycott is supported because this segment of the industry (collectivity) strongly supports the premise of unrestrained trade (a social order). Their 'standard' of corporate practice emanates from a social order. Similarly, the Department of Justice (another formal organization) may devise a set of guidelines for acceptable practices of protesting farmers in the District

of Columbia (a standard intended to apply to a 'collectivity') yet may apply the standards only to particular farmer leaders (member). Natural standards exhibit similar multi-institutional relationships. A tradition or custom may evolve at the level of an informal organization (Wednesday Supper Club) yet may, in time, become accepted (or at least be recognized but not considered applicable) on the societal level. Other examples are found in special occupational codes (say for builders or merchants) which are widely known and accepted but are incumbent only upon those occupations.

In conjunction with this discussion of the loci of standards development and use, it is important to consider the extent and mode of *enforcement* of standards. Standards vary widely in their sources of authority. Six dimensions merit mention: (1) punishment for non-compliance vs. reward for compliance; (2) extent or severity of punishment or reward; (3) internal vs. external enforcement; (4) formal vs. informal enforcement; (5) the consistency with which the standard is enforced and; (6) the sources of authority for enforcement.

Finally, standards can be differentiated according to their intended *purpose* or use. In the previous section it was noted that standards promote communication and provide psychological and economic efficiency gains. While all standards provide these benefits, at least on some general level, they are usually intended to serve other, more specific purposes, particularly formal standards. For example, many standards are explicitly intended to ensure a desired level of quality. Standards of this type cover a wide range of products, activities, processes and so on in an equally wide range of functional and sectoral areas. They are increasingly becoming more prevalent

in areas relating to industry and production; indeed, it is difficult to find a product that is not designed or produced in accordance with industry wide standards, whether for reliability, performance, health and safety or durability. Nor is it easy to find an occupation where job training and performance is not governed or at least guided by occupational codes and recommended practices. Quality standards relating to the environment are also becoming increasingly prevalent. Examples of standards for this purpose are public regulations to protect the quality of the air and water as well as standards to provide for orderly urban growth and architectural and design distinction.

Quality standards are usually of the specification type, prescribing a set of requirements associated with the desired level of quality. Sometimes they are called 'minimum standards' in that they set a minimum level of acceptable quality rather than any one particular level. Other quality standards are of the classificatory type. For example, only steels of certain classifications are allowed for use in buildings. Quality standards of this type are often called 'grading standards' as they divide products (or processes) into different levels or classifications of quality.

Another type of purpose standard is the 'uniformity standard', the intent here being to limit the variety of a product to a reasonable number, often to varieties of certain physical dimensions. (For this reason, they are sometimes called 'dimensional' standards.) Like quality standards, standards for uniformity can be further subdivided into a number of different types. Some uniformity standards are intended to ensure the interchangeability of products, for example, beds and bed sheets; 35mm slides and projectors; or the interchangeability of persons and machines, for example, standardized

typewriter keyboards and typewriter stands, and automobile seats and steering wheels. Other such standards aim to insure the interchangeability of single products, for example, railroad gauges and bricks.

Most often, uniformity standards are considered only in the context of physical products. While the vast majority of uniformity standards do pertain to products, it is important to realize that standards relating to social and economic processes and activities perform many similar functions, even though they may have developed to serve other, more immediate objectives. In many instances, activities are performed in a limited number of ways; variety is consciously reduced in order that individuals can effectively perform the same tasks or in order to insure coordination and compatibility among different but related activities. For example, in data processing, information is assembled, stored and retrieved according to established procedures. A similar standardization is apparent in many bookkeeping, accounting and management procedures.

Another purpose standard is termed the 'simplification standard', the primary intent being to limit excessive variety and thereby promote economies of scale for producers, improved information and lower costs for consumers. Examples of simplification standards include the conscious reduction of paint brush types from 480 to 138; of tacks from 428 to 181 and of files from 1350 to 496.

Another group of standards under the general rubric of purpose may be called *regulatory*; they address the issue of wise use of resources. Standards of this type are often used on a short term basis in crisis situations

such as food or fuel rationing. However, such standards are increasingly common. One such example is a step-rate structure for electricity that establishes a basic or "life-line" rate for 'standard' energy use, and increased rates for use levels above the standard.

STANDARDS DEVELOPMENT IN THE UNITED STATES

We now turn to the standards development process in the US, focusing on 'formal' standards pertaining to industry and production. The United States is very much of an anomaly in these regards. In contrast to nearly all other developed countries, there is no one major national standard setting institution. Though the National Bureau of Standards, a federal agency, does develop standards and mandate their use, for the most part the government has adopted a laissez-faire attitude. Thus the development and administration of standards in the U.S. has been essentially a private affair.

Most standardization activities in the U.S. are carried out through a loosely structured system of industry, producers, consumers and government, known as the *voluntary consensus system*. Over 400 private organizations participate in this system; however standards writing activities are actually highly concentrated. (Three organizations alone accounted for more than one half of all industrywide standards in 1964 and another fifteen for most of the remainder.)

This system is called voluntary for two reasons: first, participation in the system is voluntary, as it aims to include in standards development all those who might be affected by the standard; second, standards produced by the system are, in most cases, intended for voluntary use. The system has no formal enforcement powers as it is premised on the belief that the standard that is developed by all affected parties will be the one that is widely used.

Standards produced through the voluntary consensus system become mandatory only when they are referenced or formally adopted by a governmental body. State and local governments, for example, reference hundreds of standards developed by the system for use in building codes. Similarly, the Environmental Protection Agency, the Food and Drug Administration and other government agencies have adopted standards originating in the voluntary consensus system for regulatory purposes. In the standards writing community, standards of this type, whether developed by the governmental body or adopted for its use from voluntary standards, are known as *mandatory* standards.

The justification most frequently offered for having these two systems of standards development is that the voluntary consensus approach resolves primarily technological issues, while the mandatory system encompasses political issues as well. According to this view, most industrial standards answer simple technological questions; for example, the load bearing properties of different building materials. It is commonly believed that the standard setting tasks of this kind yield best to the combined efforts of all interested parties -- industry, the government, the consumer, the engineer -- in short, any "analytic talent" willing to participate.

Setting a limit on "how much is safe" (for example, on the amount of sulphur to be permitted in stack emissions or the chemical content of foods) is by comparison a political question (that is, one for which there are several compelling standards of judgement, meaning that the issue cannot be settled on the basis of technical expertise alone.) The bifurcation yields a tendency to de-politicize technical questions and, conversely, to de-technicalize what are called 'political' questions. Nevertheless it is

obvious that to the extent that an issue can be reduced to technical terms (that is, terms which themselves are, by definition, standardized) the probability of a standard being set is much higher.

A classic example of the private-public, technical-political problem in standards setting is the railroad gauge standard of 1863. When railroads were first introduced in the U.S., track gauge (the distance between rails) varied from 3 to 6 feet. These variations, of course, prevented the railroad industry from taking advantage of the increasing mileage in rail lines as different trains and gauges were not 'interchangable', at significant cost to rail users. To solve this problem, Congress stepped in and mandated a uniform rail gauge of 4 feet 8 1/2 inches, reducing the number of gauges from thirty-three to one. So, by the 1880's, all trains ran on uniform interchangeable rails, and rail cars were produced for this size track, gaining economies of scale in products.

In this example, government action was necessary because there were high costs involved in foregoing standardization. Despite the obvious technical inefficiencies, the voluntary consensus system seemed unlikely to come to an agreement in any reasonable length of time, if at all. Each railroad company (and its various technicians -- civil engineers, mechanical engineers, train and gauge builders) was strongly biased toward its own gauge size -- a symbol of the private interest/competitive advantage of each line. There was no incentive to compromise as no one gauge size was decidedly superior to any other. For each company the ultimate dominance of its own gauge held the potential of enormous profit.

This example does not mean that agreement on standard(s) can never be achieved or that the interests of diverse, even conflicting groups cannot be accommodated through the voluntary consensus system. Indeed, conflicting viewpoints are expected and at least in theory, the system is intended to serve as a forum for identifying, considering and incorporating the viewpoints of individuals and organizations having an interest in the development of a standard. (Sometimes, of course the inclusion of conflicting viewpoints and their proponents does not occur, or when it does, it is at considerable loss of either time or quality. This suggests that the need for government intervention may be greater than is commonly acknowledged by the proponents of the system.) Indeed, the voluntary consensus system is explicitly based on the premise of considering the views of all parties having a stake in an issue. The assertion most frequently put forth in support is the "the more voices heard in the standards forum, the more likely the standard will be unbiased, enjoy the highest credibility and be adhered to". (ASTM, 1975).

While the theoretical justifications are straight forward, the voluntary consensus system operates in a highly complex and often confusing manner. Indeed, at first blush, the process of standards development appears anything but standardized. To obtain a better understanding of the operation of this in the U.S. system we will first distinguish among the different types of standards that are produced and then consider some of the approaches to standards development.

Because most standards are premised on the achievement of consensus, the standards writing community usually classifies standards according to the

level at which consensus is achieved in the development process. ASTM, for example, identifies five levels of consensus: (1) the company standard; (2) the industry standard; (3) the professional standard; (4) the government standard; (5) the full consensus standard.. In the *company* standard, consensus is achieved among employees of a formal organization, either all employees, or employees in specified departments. For example, at Dunkin Donuts, certain pastries are "baked fresh daily". The standard is acknowledged by a broad public but only employees are bound to meet the standard. Any other pastry company may or may not choose to adopt this standard for its products. In this instance (and for all company level standards) enforcement is largely internal. It is presumed that the company will abide by its standards for the sake of its public image as well as the possibility of charges of fraudulent advertising.

At the next levels, the *industry* and *professional* standards, consensus is achieved among all firms in an industry and all members of a profession, respectively. Here too, enforcement is largely internal, although on the industry or profession levels, individual firms and professionals must contend with pressures imposed by their competitors and colleagues. Of course, the extent of internal and external enforcement pressures will depend on the type of standard in question as well as the nature of the profession or industry. If, for example, compliance with an industry level standard was critical for the successful marketing of industry products (say the industry produced a good requiring interchangeability with goods produced in other industries and the standard in question specified the dimensions of the product) no external pressures would be relevant; without adhering to the standards, the

industry (or company within it) simply would not exist. If on the other hand, a major manufacturer decided to ignore an interchangeability standard and could do this to his advantage (say, the manufacturer also began producing the complementary good) one would obviously expect there to be a good deal of protest from other industry members. In this case, the other firms could not by themselves compel the manufacturer to comply with the standard although they might appeal to the courts on the grounds of restraint of trade, anti-trust or the like, depending on the particulars of the case. Although these are extreme examples, they are indicative of the types of enforcement pressures engendered on these levels.

There are two types of *government* standards identified by ASTM. The first is a purchasing specification of a governmental agency or department. For example, public schools, state and local governments and federal agencies all have specification standards (whether they have been developed in-house or adapted from the voluntary consensus system) which suppliers of various products must meet. This is in contrast to a mandatory standard (described earlier) which the government sets or adopts for others to follow. Enforcement in the first case rests, of course, with the particular government agency. If a firm wishes to do business with the government it must abide by the standards identified. Obviously, firms contracting with the government but not meeting contract standards will not only be precluded from further business dealings with the government but may be liable for breach of contract and the like.

Finally, a *full consensus* standard implies consensus of a substantial number of elements of a community having an interest in the development and/or

use of a standard. Ideally, the standard is developed and accepted by a combination of producers, consumers, labor groups, and the government -- in short, anyone potentially affected by the standard. To qualify for full consensus status, standards must be produced under the auspices of a body organized and conducted in accordance with procedural standards of due process. (More will be said about this shortly.) Enforcement for full consensus standards is largely similar to industry and professional standards. Again, there are no formal means of enforcement. However, there is often considerable pressure (both internal and external, from consumer groups and other organizations to whom the standards apply) to conform to the standard. For example, a firm not complying with a full consensus minimum quality standard may come under attack by a competitor, a consumer group or the organization under whose auspices the standard originated. Again, like industry and professional standards, the extent of internal and external enforcement pressures will depend on the nature of the standard and the ease with which non-conformance can be detected.

Nearly all of the standards just described (i.e. all above the company level) are developed by trade associations and professional societies, as these groups provide the trusted means for formally assembling participants for standard setting. To these organizations are added a small group of less easily categorizable organizations including the ASTM, the National Fire Protection Agency (NFPA), Underwriters Laboratory (UL), the National Bureau of Standards (NBS) and others with a central interest in standard setting. Theoretically, any organization with authorization for standard writing in its by-laws can write or initiate the development of an industry, profession,

government and/or full consensus standard. As one would expect, standards are typically developed under the auspices of an organization with technical capabilities in the area of the standard. However, in the loosely organized voluntary consensus system, no particular group or organization has official responsibility for initiating or developing standards in any one area.

The need and initiation for standards development might be undertaken by producers in an industry concerned about the lack of consensus in some area (say fire resistance in cellulose insulation), by wholesale or retail distributors of the good, by a consumer group concerned about the quality of the good, or by a government agency.

The agency or organization which in the end leads the investigation for and development of the standard depends, in large measure, on the technical resources that are necessary and the type of standard that is desired. As noted, no standards excepting mandatory standards have full legal standing. However, standards at different levels of consensus engender different internal and external enforcement pressures. As a consequence of different membership policies, widely varying technical skills and resources and different standard development procedures, the standards produced by different standard writing organizations are normally accorded varying degrees of status and respect. For example, standards produced by trade associations and professional societies are usually not considered *full-consensus standards* because their membership is restricted to individuals and firms in their industry. Standard writing activities are usually secondary to the promotion of professional and commercial activities. However, in the event that these organizations do desire to attain full consensus status for their standards, they can do so

by submitting them to the American National Standard Institute (ANSI), the national coordinator and clearinghouse for standards and the only recognized non-governmental organization in the system, for determination of national consensus. The standards of other organizations, the ASTM for example, who have more open membership policies and formal procedures for assuring that all groups have a voice in standards development, are more easily accorded full-consensus status. Standards produced by the ASTM must still be submitted to the ANSI for 'formal' determination; however, they are essentially accorded full consensus status on their own. In this case, review by the ANSI is largely a formality.

At present, there exist no official procedural rules for organizations aiming to produce full consensus as contrasted to industry or profession wide standards, nor any formal guidelines that explain just which procedures qualify for which status. (The Federal Trade Commission has proposed a rule on Standards and Certification. FTC, 1978.) In spite of this lack of formal documentation, the procedures of standard writing efforts aiming to qualify for full consensus standing generally are founded on similar legal principles. For example, most organizations have explicit procedures to ensure conformance with the principles of due process, including: an adequate notice of the proposed standards undertaking to all persons, companies and organizations likely to be affected; opportunity for participation in meetings, standard drafting sessions and the like; and careful attention to minority opinions. Additionally, most standard writing organizations aiming to produce full consensus standards have rules and procedural standards intended to safeguard the standards development process from anti-competitive motives, including rules regarding the

make-up of the standing technical committees, rules governing voting authority as well as provisions for the review and possible revision of existing standards.

Adherence to these principles as well as technical competency in the standards developed are important, (at least in theory), because of the liability of standard writing organizations. Though they have no legal enforcement powers, organizations holding themselves to be experts on standards and publishing them for use by the public are liable for the standards that they produce and promulgate.

The following several pages present an examination of some of the major standard writing organizations, specifically trade associations, professional societies (including engineering societies), government standard setting bodies and finally, a group of standards organizations of major importance in the standard writing community. These organizations will be considered according to the types of standards produced, the services they provide and their relationships to other standard setting bodies.

Trade Associations

Trade associations are typically non-profit organizations comprised of independent businesses in a single industry or trade. Generally, their purpose is to improve the position of their members relative to competing industries. The range of services provided varies by industry, on sales, profits, investment levels and the like; provide assistance in different functional areas (for example, management, marketing and accounting) and promote and coordinate joint efforts among industry members (for example, research, advertising and standards development). They also serve as the industry liaison to the public, labor unions, the government and other industries. Most associations finance their activities through membership dues, an industry journal and/or other promotion-type efforts.

Trade associations vary considerably in the importance they attach to standards development as well as in the types of standards they produce. This will depend, in large part, on the incentive of the firms in the industry. Some industries have an obvious incentive to develop standards of specific types. For example, uniformity and measurement standards are critical for the successful marketing of clothing and apparel (as well as for economies of scale in production). Thus we find that the National Association of Hosiery Manufacturers has developed a uniform measurement system for its products. In other industries where consumer safety and product reliability are important, trade associations have been active in developing specifications, test methods and grading standards to ensure that industry products meet minimum levels of quality. For example, the American Gas Association (AGA) has developed testing and certification procedures for nearly all types of domestic, commercial and industrial gas accessories. Products which have been approved in the Association's Laboratories can display the Association's registered seal of approval indicating that they have been tested and are in compliance with all Association requirements in effect at the time approval was granted.

Assurance of a least minimum levels of quality are, of course, important to all industries. Trade associations frequently try to upgrade the average quality of products in their industry through grading and minimum quality standards. It is important to realize though, that some industries may take the opposite route and directly discourage industry-wide standards, particularly those relating to product quality. In the drug and cosmetic industries, for example, where brand name is very important, there is obviously little incentive

to set industry-wide minimum quality standards, as product differentiation and the competitive advantage of the industry's leading firms would be seriously diminished.

The nature and importance of standards development activities among trade associations may also depend on each associations' organization and membership. For example, associations composed of companies that are only horizontally related may encounter difficulties in writing standards for goods further along in the production process, i.e. interchangeability standards. Standards of this type would have to be developed under the auspices of organizations having broader more vertical membership. On the other hand, trade associations like the AGA include firms that are both horizontally and vertically related and consequently develop a wide range of interchangeability standards among others.

As noted earlier, standards produced by trade associations are not accorded full consensus status because they usually garner a consensus only among industry producers or suppliers. In the development of quality related standards, trade associations sometimes invite consumers to sit on their committees or seek the opinions of consumer groups or individual customers. However, this is usually not done on any systematic basis, and these groups are rarely given voting authority in the development process. For these reasons and because they are sometimes lacking in the requisite technical or financial resources, many trade associations, in fact, have formal representation or informal liaison with some of the larger standard writing organizations. In these instances, when representatives are sent to sit on standard writing committees outside of the industry, they are intended to serve as representatives of the industry as opposed to the employing company. Another route to

achieving full consensus status is to submit the standards to ANSI for the formal determination of national consensus. This approach is typically employed only by the largest trade associations or those that are very active in standards development.

PROFESSIONAL SOCIETIES

Professional societies are organized along the same lines as trade associations except that members are individuals rather than firms. Individuals do not serve as representatives of the firms with which they are affiliated but as independent members of the profession. Membership policies of professional societies are typically more restrictive than those of the trade associations. Membership is often stratified according to years of education, practice and professional accomplishments; governing positions on boards and committees are usually limited to individuals with specified credentials.

Professional societies serve many of the same functions as the trade associations, i.e. they serve as the profession's representative to the government and the public, promote and coordinate profession-wide events and most generally, provide a forum for discussion of profession-related concerns. Yet the typical professional society takes a more active role in research and educational matters. For example, the primary purpose of engineering societies is the advancement and dissemination of engineering knowledge. Most of these societies sponsor a good deal of research and provide technical advice and information to their members.

As in the case of trade associations, the nature and importance of standard writing activities varies greatly among the societies. While some are highly active in developing and promulgating a wide variety of standards (for example, the Association of Official Analytical Chemists, which develops

test methods for the analysis of materials relating to agriculture and public health, or the more well known Association of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)), most professional societies do not view themselves as standard writing bodies. For example, the American Society for Civil Engineers (ASCE) views standards development activities as of minor importance in comparison to its research and other educational functions, although members of the society frequently sit on the standard writing committees at ASTM, ANSI and other standard writing organizations.

Because of these widely varying attitudes towards standards development, there is no systematic way of describing the standard setting activities of professional societies. However, as a general rule, when they do engage in standards development, professional societies do not set minimum quality standards or 'put in numbers'. They will set the standard procedure to determine performance (i.e. technical and scientific problems) but not how high or low that performance should be. For example, one standard of the Institute of Electrical and Electronic Engineers (IEEE) is concerned with test procedures for measuring the noise of rotating electrical machinery; however, it does not stipulate what level should be expected of normal commercial apparatus. In their view, this determination is more appropriate for a trade association, for example, the National Electrical Manufacturers Association (NEMA). Two major exceptions to this trend are the Society of Automotive Engineers (SAE) and the American Society of Mechanical Engineers (ASME) who both "put in numbers" and in this sense, function more like trade associations. (Hemenway, pp. 84-5)

Whether a standard is written by a trade association or professional society may also depend on historical precedent. Certain trade associations are relatively inactive in standard writing because of the existence of a professional society with a long history of involvement with standards. For example, nearly all standardization work in the automobile industry is carried out through the SAE as opposed to the Automobile Manufacturers Association (AMA). However, the AMA does help to finance the SAE and is engaged in standard-writing activities through its membership in the ASTM and ANSI.

Participation in the technical work of other standard writing organizations, is, in fact, an extremely important role played by the professional societies. Even when standards development is secondary in importance to other society activities, because of the technical expertise of their members, professional societies are of obvious importance in the standards development process. As noted before, members of the ASCE participate in the standard writing activities of ASTM and ANSI and building code writing organizations. Similarly, members of the IEEE assist Underwriters Laboratory in addition to developing standards through their own organization. In fact, nearly all professional societies are in some way involved with the standards development activities of other organizations.

STANDARDS ORGANIZATIONS

The premier standards preparing organization in the U.S. is the American Society for Testing and Materials (ASTM). ASTM is a national non-profit technical, scientific and educational society, established in 1898 for "the promotion of knowledge of engineering and the standardization of specifications and test methods". The Society's main work today concerns

standardization and research in materials, specifically relating to quality and testing, with lesser emphasis on dimensional standards and design issues. ASTM membership includes both individuals and organizations. Because of its extensive relations with others in the loosely knit system ASTM serves a critically important coordinating function, preventing overlapping and duplication of activities.

The standards development process at ASTM is also notable. Most of the work is carried out through ASTM's standing technical committees which are divided into main committees, subcommittees within the main committees and task groups which are usually drawn from the subcommittees. It is the job of the task group to initiate draft standards. Task groups have no officers; leaders are usually appointed on an ad hoc basis. Subcommittees are comprised of individuals with expertise in specific areas related to the work of the main committee. A fourth committee segment is the executive subcommittee which is usually comprised of the main committee officers, the subcommittee chairpersons and frequently, some members at large. This is essentially a management body with responsibility for guiding the main committee and the subcommittees.

In the standards development process these committees are governed by strict rules for procedure to insure that standards developed reflect full consensus. For example, in all committees dealing with materials, products systems, or services having a commercial bearing:

"The number of producer members must not exceed the number of non-producer members."

"The chairman of the main committee as well as chairman of the executive subcommittee must be a non-producer"...

"There are only two justifiable reasons for refusing voting membership on a committee to any ASTM member a) if his election would create an imbalance of the voting interest, or b) if he is not technically qualified or knowledgeable in the area of the committee's scope. (A consumer is assumed to be knowledgeable.)"

"All negative votes on committee ballots must be considered by the originating committee, and action taken in response to a negative ballot must be an affirmative vote of not less than two thirds of those voting."

"All committee meetings considering technical matters relating to standards must be open to visitors."

"Validated test data must be a part of standards actions whenever applicable."

"All standards actions must be "equitable" meaning every organization large and small and every individual member is given a vote."(ASTM, 1975, pp 23-4.)

Because of these and other ASTM requirements, ASTM standards development procedures are usually considered the best and most rigorous for the development of 'full consensus' standards. For these reasons, standards produced by the ASTM are often considered to be the most technically sound and representative of the general interest.

Two other important standard writing organizations are the National Fire Protection Association (NFPA) and Underwriters Laboratory (UL). NFPA is a non-profit technical and educational organization whose principal functions include the development of engineering standards and recommended practices for fire protection and the education of the public in regard to fire prevention techniques. NFPA's membership includes over 2700 individuals and organizations and is drawn from fire service centers, business and industry, health care, academic, insurance companies, government and engineering. Like ASTM, NFPA plays an important coordinating role and frequently collaborates with other standard-writing organizations. For example, NFPA co-sponsored

the development of standards with the IEEE (e.g., the National Electric Code and the Lighting Protection Code) as well as a series of standards with the AGA on the installation of gas appliances and gas piping. Many of NFPA's standards are used for insurance purposes; many are adopted in federal, state and municipal regulations.

Underwriters Laboratory (UL), a not-for-profit corporation which is sponsored by the American Insurance Association, is primarily a testing laboratory which rates products, systems and materials in regard to fire and other safety hazards. The Laboratory is divided into several engineering departments: burglary protection, casualty and automotive, chemical, electrical, gases and oils and fire protection. Each department has prepared standards providing specifications and requirements for construction and performance under test conditions and actual use. Products which have passed UL requirements are 'listed' in the published records of the Laboratory and are entitled to bear the Underwriters Laboratory Certification Label. Additionally, UL sometime writes recommended practice standards to the products tested. Underwriters Laboratory's test labs are maintained throughout the country; periodic inspections are conducted in the factories where listed devices are manufactured. The majority of underwriters in the U.S. and many federal, state and municipal authorities require listing by the Laboratory as a condition of their recognition and use of devices and products.

Because of the wide range of concerns, Underwriters Laboratory also helps to coordinate activities and avoid duplication of effort in the standards writing community. UL frequently cooperates with the NFPA and is represented on many of the technical committees of the ASTM and ANSI.

One other group of standard writing organizations is the building code organizations. Many of the organizations described above develop standards for use in buildings; however, most building construction is governed by the standards developed by the model building code associations and allied groups.

The first model code was written by the National Board of Fire Underwriters in 1905 (now the American Insurance Association). This code, now known as the National Building Code, is drafted by engineers from AIA with assistance from other standard writing groups. There are presently three other model code organizations which are regionally located; the Building Officials and Code Administrators Inc. (BOCA) which prints The Basic Building Code; the International Conference of Building Officials (ICBO) drafts the Uniform Building Code; and the Southern Building Code Conference International Inc. (SBCC), which prepares the Standard Building Code. These three organizations formed the Council of American Building Officials (CABO), in 1971, to provide for more coordination and to work towards uniformity in building codes. Some of the other organizations concerned with building code development include the American Major City Building Officials (AMCBO), the International Association of Plumbing and Mechanical Officials (IAPMO) and the National Conference of States on Building Codes and Standards (NCSBCS).

The final organization, a central figure in the voluntary consensus system, is the American National Standards Institute (ANSI). Until 1969, ANSI was known as the American Standards Association and before that the American Engineering Standards Committee. It was founded in 1918 by the ASTM and four other engineering societies. Today, ANSI is a voluntary federation of more than 160 standard writing organizations (trade, technical, professional

and consumer organizations which serve as 'member bodies') together with more than 1000 'company members (industrial and commercial firms).

ANSI has three principal functions. First, it serves as the official coordinator for all of the other organizations operating in the voluntary consensus system. It both helps to identify the standards that are needed and arranges for organizations to develop them. In the event that a standard writing organization does not exist in a particular area of need, ANSI organizes technical committees from its own members to draft needed standards. ANSI has formed over 270 technical committees to work on standards in a wide range of fields. Each technical committee has a 'secretariat', an organization (trade association, professional society, ASTM and so on) with a major interest in that field of standards development, responsible for administering the work of the committee. Because ANSI may not by its constitution write standards, it does not 'own' its technical committees. Instead, they belong to the organizations which comprise them. Also, as part of its coordinating role, ANSI aims to prevent duplication of effort in standard writing activities. If, for example, ASME is developing a standard in one area it is ANSI's job to dissuade other organizations from commencing work in the same area.

Second, ANSI establishes national consensus standards. As noted earlier ANSI is the only internationally recognized non-governmental standards working entity in the system. Other standard writing organizations can submit their standards to ANSI for determination of national consensus. Like ASTM, ANSI's operations are governed by rules and regulations to ensure due process, including the right to appeal at several levels of review.

Also, ANSI has a Consumer Council which is empowered to review standards for consumer products and services submitted for full consensus.

The third major function of ANSI is its representation of U.S. interests in international standardization carried out by non treaty organizations such as the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC). ANSI is the official U.S. member in these organizations and actively participates in the work of their technical committees.

ANSI finances its operations through membership dues, by the sales of its standards (i.e. American National Standards), ISO and IEC documents and by industry and government grants for special projects.

GOVERNMENT STANDARDS SETTING BODIES

Aside from the specifications created in various governmental departments, the federal government takes part in the voluntary consensus system through the National Bureau of Standards, a part of the Commerce Department. This Bureau was established in 1901 to meet the needs of a unified measurement system. Most of the work at the NBS is carried out through its five major technical units: the Institute for Basic Standards, the Institute for Materials Research, the Institute for Applied Technology, the Institute for Computer Sciences and Technology, and the Office of Information Programs.

The Bureau functions as a sort of science research facility for the federal government. Today, the Bureau's activities center in three main areas. The first concerns the custody, maintenance and development of national standards for measurement; the second, materials research (the determination of physical constants and properties of materials as well as the development

of methods for testing materials and structures); and the third, the testing of materials and equipment and the development of product standards. Many of the product standards developed by the Bureau are referenced in contracts, labels, invoices or advertising literature. Like standards developed by private organizations, the provisions only become enforceable when they are incorporated into sales contracts.

NBS committees operate in much the same way as those in the private sector. While the product standards developed by the NBS are initiated in-house, the Bureau distributes circulars of proposed standards to appropriate producers, consumers, users and other interested groups for consideration and comments. A Standards Review Committee is later established, consisting of producers, distributors, consumers and users. If objections are raised by committee members, further adjustments are made; if the objections are rejected in the end by the majority, however, the committee is required to provide information concerning its reasons for rejection. Following publication of the standard, a standing committee is established (representative of the industry and 'adequately' balanced among producers, distributors and consumers) to revise or amend the standard in the event of changed circumstances.

The NBS has long been involved with other organizations in the voluntary consensus system. For example, the director of the NBS staff is on the governing board of ANSI as well as ASTM and many members of the Bureau participate on the technical committees of other standard writing organizations. (There are presently over 200 Bureau members on ASTM Committees alone.) Also, among other activities, the NBS sponsors the National Conference of Standards Laboratories (NCSL) and the National Conference of Weights and Measures

(NCWM). The former is an organization of measurement standards and calibration laboratories and the latter comprises state and local weights and measures officials, representatives of weighting and measuring device manufacturers, trade associations and industrial users.

AFTERWORD

This paper has reviewed standards in the United States. It has presented a conceptual framework for understanding standards, suggested several approaches to categorizing standards and provided an overview of the standards development process as currently practiced in the U.S. As such, the paper provides a convenient reference document in understanding efforts to incorporate innovations into the housing sector. The sine qua non of prompting innovation acceptance is that the innovation be standardized. Misunderstanding the nature of standards, or the process of standards development, can lead to significant institutional barriers to innovation acceptance. Thus those wishing to promote acceptance of solar technologies in the housing sector will be well served to note closely the information provided here.

REFERENCES

AMERICAN SOCIETY FOR TESTING AND MATERIALS. (1975) THE VOLUNTARY STANDARDS SYSTEM OF THE UNITED STATES OF AMERICA, Philadelphia.

AMERICAN SOCIETY FOR TESTING AND MATERIALS. (1975) PRINCIPLES AND PRACTICES OF STANDARDIZATION. Philadelphia.

BERGER, Peter L. and Thomas Luckmann. (1967) THE SOCIAL CONSTRUCTION OF REALITY: A TREATISE IN THE SOCIOLOGY OF KNOWLEDGE. Garden City: Doubleday Anchor Book.

FEDERAL TRADE COMMISSION. (1978) STANDARDS AND CERTIFICATION: PROPOSED TRADE RULE AND STAFF REPORT. Washington: FTC Bureau of Consumer Protection.

FURLONG, Michael and Thomas E. Nutt-Powell. (1979) INSTITUTIONAL ANALYSIS OF RESEARCH AND SOCIALIZATION IN HOUSING: A PRELIMINARY EXPLORATION. Cambridge, MA: MIT Energy Laboratory.

HEMENWAY, David. (1975) INDUSTRYWIDE VOLUNTARY PRODUCT STANDARDS. Cambridge, MA: Valliger Publishing Co.

MCDANIEL, Patricia and Thomas E. Nutt-Powell. (1978) INSTITUTIONAL ANALYSIS OF GOVERNMENT INVOLVEMENT IN HOUSING: A PRELIMINARY EXPLORATION. Cambridge, MA: MIT Energy Laboratory.

NUTT-POWELL, Thomas E. with Stewart Landers, Bonnie R. Nutt-Powell and Levi Sorrell. (1978) TOWARD A THEORY OF INSTITUTIONAL ANALYSIS. Cambridge, MA: MIT Energy Laboratory.

REAMER, Andrew, Steven Heim and Thomas E. Nutt-Powell. (1979) INSTITUTIONAL ANALYSIS OF ENERGY PROVISION IN HOUSING: A PRELIMINARY EXPLORATION. Cambridge, MA: MIT Energy Laboratory.

SWETKY, Carole and Thomas E. Nutt-Powell. (1979) INSTITUTIONAL ANALYSIS OF HOUSING PRODUCTION: A PRELIMINARY EXPLORATION. Cambridge, MA: MIT Energy Laboratory.

UNITED NATIONS DEPARTMENT OF ECONOMIC AND SOCIAL AFFAIRS. (1964) INDUSTRIAL STANDARDIZATION IN DEVELOPING COUNTRIES. New York: United Nations.