International Standards for Reactor Technology

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Abstract

The role of normative standards is to enhance the economic competitiveness of a nation by facilitating the free exchange of goods and services. Approximately 80 percent of all globally traded products are affected by standards and regulations that embody standards. In the present paper we provide a general discussion about the role of normative standards both in the United States and globally, and conclude with a specific discussion of international standards in the area of reactor technology.

KEYWORDS: International Standards, Reactor Technology, ISO

1. Introduction

Independent of their associated industrial sectors, the role of normative standards is to enhance the economic competitiveness of a nation by facilitating the exchange of goods and services. According to National Institute of Standards and Technology testimony before the House Committee on Science, Subcommittee on Technology, September 13, 2000, about 80 percent of globally traded products are affected by standards and regulations that embody standards. Normative standards play many important and key roles in our society allowing for a common language between purchasers and sellers, defining interoperability among different technologies, disseminating new technologies, and promoting quality and innovation. However, even though standards play a major role in society, many people commonly misunderstand or under-appreciate the importance of that role. In the present paper we provide a general background discussion about standards both in the United States and globally, and conclude with a specific discussion of international standards in the reactor technology area.

2. The US National Standards System

Nations around the world operate under different models for standardization. The relative success of any particular model depends largely on the economic and legal development within an individual country. Although the administration of any standardization system within the prevailing government-industry infrastructure of a particular nation may vary, the above-stated role for standards development and implementation remains true. Thus, the U.S. standardization system provides an appropriate model for understanding the role of normative standards within the greater international market-place.

Within the United States, the system of standards presently in place has evolved in response to changes in our nation's economy, as a market-driven society. Until just a few decades ago the

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U.S. market was primarily domestic; accordingly, the standards developed addressed mainly internal economic requirements. These standards worked well to support the domestic goals of health, safety, protection of the environment, and, above all else, specification of products, processes and systems. For example, the National Fire Protection Association (NFPA) developed the Life Safety Code, which has been incorporated into most local building codes. In addition, NFPA, along with the National Electrical Manufacturer's Association (NEMA), developed and promulgated the National Electrical Code, an installation code for electrical equipment used across the United States. In other areas, the American Society of Mechanical Engineers developed the Elevator (lift) code that is used in most of North America, as well as the Boiler and Pressure Vessel Code.[1-2]

Voluntary standardization activities in the United States are private sector-led, with government participation. These activities are broad, complex, decentralized and naturally partitioned into industrial sectors, which are supported by numerous independent, private-sector standards developing organizations, otherwise known as SDOs. Currently there are more than 450 SDOs, the work of which is augmented by at least an additional 150 standards-related consortia and fora. In the U.S. standards system no single organization controls the process. However, there is one umbrella organization that administers and coordinates the normative standards activities in the United States: this organization is the American National Standards Institute (ANSI). ANSI is a private, non-profit, membership organization which was founded in 1918, to enhance the global competitiveness of U.S. business and the U.S. quality of life by promoting and facilitating voluntary consensus standards and conformity assessment systems, and safeguarding their integrity. ANSI does not develop standards. ANSI does, however, serve as a clearinghouse and coordinator for U.S. standards activities for its members organizations, comprised of companies, government agencies, SDOs, and consumer representatives, among others. ANSI provides guidelines for the development of standards based on the cardinal principles of openness, transparency, consensus and due process, which are discussed in further detail below. Moreover, ANSI accredits U.S. SDOs that comply with these procedures. Accredited SDOs in turn may choose to have select standards approved and distributed by ANSI as an American National Standard (ANS). It is a purely voluntary choice which is based on the perceived value added to the marketability of the standard(s) that the individual SDO places on the ANS marking. Consequently many U.S. standards may have dual or triple designation, such as ANS/ASTM E2336-04 Standard Test Methods for Fire Resistive Grease Duct Enclosure Systems, ANSI/ASAE EP406.4 JAN03 Heating, Ventilating and Cooling Greenhouses, ANSI INCITS 117-1984 (R2002) Printable/Image Areas for Text and Facsimile Communication Equipment (formerly ANSI X3.117-1984 (R2002)). ANSI has accredited at least 200 SDOs and now lists over 14000 of their standards as American National Standards.

As stated earlier, the key concepts in the U.S. standardization process are *openness*, *transparency*, *consensus* and *due process*. *Openness* refers to the opportunity that exists for participation in the standards development process by anyone who has a stake or vested interest in the subject of a proposed standard. *Transparency* refers to the timely availability of information on proposed standards actions. *Consensus* is the substantial agreement reached by concerned interests, after a concerted attempt has been made at resolving all objections. Consensus implies much more than the concept of a simple majority, but does not necessarily imply unanimity. As such, achieving consensus among interested parties during the development of a standard clearly increases its prospect for broader acceptability and use in the

market place. Finally, *due process* refers to the assurance that all viewpoints are considered on the basis of merit, and that there are administrative procedures in place that govern the decision making process to include: use of objective and fair procedures, public access to information, and accountability of the standards developer through formal appeals. These four concepts result in an open, competitive U.S. standardization system that has produced standards widely recognized for their high-quality technical content and fair approach. The entire system is termed "voluntary" because committee members participate on a voluntary basis, and because compliance with the standards is voluntary, except in those cases in which the standards have been subsequently adopted or referenced by a government regulatory authority. These voluntary standards may in turn be used by industry to build and test products and systems, or by government agencies at all levels to either supplement regulations or to procure products for their use. The U.S. normative standardization system has effectively met the nation's needs in a timely fashion primarily due to the full engagement in the process by both the private and public sectors.

The hundreds of U.S. SDO's fall into four categories: (a) Professional Societies, such as the American Society of Mechanical Engineers (ASME) and the American Nuclear Society (ANS), whose members seek to advance their professions, but which also develop standards; (b) Trade Associations, such as the Electronic Industries Association (EIA) and the American Gas Association (AGA), which promote the products of their membership and which also develop standards; (c) testing and certifying organizations, such as Underwriters Laboratories (UL) and Factory Mutual (FM), which produce their own standards as well as using the standards of other organizations; and (d) solely standards developing organizations. This latter category includes, in particular, the National Fire Protection Association and ASTM International, formerly known as the American Society for Testing and Materials, which accounts for more than 20% of all U.S. voluntary standards. Major challenges for many standards organizations are the needs to recover the operating costs associated with the process of developing standards – often by the sale of documents – and to preserve their intellectual property rights. Even though there exist a large number of U.S. SDOs, approximately 20 SDOs develop about 80% of standards used in the United States, as presented in the tables below.

Table 1: 20 Major Non-Governmental U.S. Standards Developers

Organization	Number of standards produced
Aerospace Industries Association	3,000
American Association of Blood Banks	500
American Association of State Highway and Transportation Officials	1,100
American Conference of Government Industrial Hygienists	750
American Oil Chemists Society	410
American Petroleum Institute	500
American Railway Engineers Association	400
American Society for Testing and Materials	9,900
American Society of Mechanical Engineers	600

Association of American Railroads	1,400
AOAC International	2,100
Cosmetic, Toiletry & Fragrance Association	800
Electronic Industries Alliance	1,300
Institute of Electrical and Electronics Engineers	680
National Association of Photographic Manufacturers	475
National Fire Protection Associations	312
Semiconductor Equipment and Materials International	450
Society of Automotive Engineers International	4,550
Underwriters Laboratories	780
U.S. Pharmacopeial Convention	5,000
American National Standards Institute	13,000[1]

The United States currently maintains about 93,000 standards in an active status as shown in Table 2, which displays the major categories of standards developers and their respective output.

Table 2: Standards activity within and outside of the Federal Government

Table 2

Federal Government	No. Standards	Non-Government	No. Standards
Department of Defense	34,000 [2]	Scientific and Professional Societies	14,000
General Services Admin.	2,000	Standards Developing Organizations	17,000
Other federal agencies	8,000	Trade Associations	16,000
		Developers of Informal Standards (Consortia)	2,000
Total government	44,000	Total non-government	49,000

[1]These standards were developed by organizations other than ANSI and then published and copyrighted by ANSI as American National Standards.

[2]It is important to note that these figures are steadily declining as the U.S. Department of Defense (DOD) cancels military specifications (MILSPECs) in favor of commercial standards as part of its acquisition reform activities. At last count, DOD had replaced almost 7900 MILSPECs with voluntary standards.

The Federal Government is included in the Table 2 as a (presently) infrequent developer of standards for both procurement and regulatory purposes. Notwithstanding, the development of government-unique standards has declined tremendously due to the National Technology Transfer and Advancement Act of 1995 (Public Law (PL) 104-113), which requires U.S. Federal Agencies to adopt private sector standards, particularly those developed by standards developing organizations (SDOs), wherever possible in lieu of creating proprietary, non-consensus standards. Furthermore, the NTTAA directs NIST: (a) to coordinate with other U.S. Federal Agencies as well as state and local governments to achieve greater reliance on voluntary standards and lessened dependence on in-house standards; (b) to assist U.S. Federal Agencies in identifying standards used in manufacturing, commerce, industry, and educational institutions that might have applicability for use by the Federal Government; and (c) to coordinate greater use of private sector standards by Federal Agencies, and state and local governments via the Interagency Committee on Standards Policy (ICSP). For the complete text the reader is referred to: http://ts.nist.gov/ts/htdocs/210/nttaa/113.htm.

3. International Standardization

The existence of non-harmonized standards for similar technologies in different countries can contribute to so-called "technical barriers to trade". Export-minded industries have long been aware of the advantages of using globally accepted standards to facilitate international trade. International standardization is well-established for many technologies in such diverse fields as information processing and communications, packaging, distribution of goods, energy production and utilization, shipbuilding, and banking and financial services. A subtle, albeit important, distinction between the objectives of national and international standardization is that an underlying motivation for national standards developed by national standard bodies is to improve directly the global competitiveness of that nation's businesses over those of other nations; whereas, international standardization strives to promote equal access to international markets by all participating nations. International standards have, however, no legal status and their adoption is purely voluntary, unless, of course, a regulatory authority passes specific legislation requiring conformance to the standard. International standards are therefore only valuable when they are used appropriately to provide maximum benefits to society at large.

The World Trade Organization's (WTO) Agreement on Technical Barriers to Trade (TBT), with 149 members as of Dec. 11, 2005, explicitly recognizes that international standards play a critical role in improving industrial efficiency and facilitating world trade. The number of National Standards Bodies from around the world which have accepted the Code of Good Practice for the Preparation, Adoption and Application of Standards presented in Annex 3 to the WTO's TBT Agreement, which also emphasizes the global importance of standards that help, not hinder, trade

So the question quite naturally arises as to precisely what constitutes an international standard. This is a question that may at first glance appear to be readily answered as: an international standard is one that has been developed through a process that is open to participation by all interested countries, transparent, consensus-based, and provides all interested parties with the provision for due process. In the U.S., however, there are many SDOs that: (a) have an international technical membership in their standards development committees; (b) adhere to the principles spelled out in the Code of Good Practice regarding, openness,

transparency, consensus and due process; and (c) whose standards have been adopted in many parts of the world for their technical rigor and market relevance. One might ask whether the standards developed by organizations of this character are considered "international" standards, or whether they are national standards by virtue of the fact that the SDO is primarily domiciled in the United States. Considering this perspective, the question of what constitutes an international standard or an International Developing Organization is no longer quite so simple to answer. This question has given rise to extensive and animated debates regarding the merits of this point of view, especially since the WTO TBT Agreement promotes the use of "international standards," but neither defines the term, nor calls-out specifically the standards developed by the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC). These two organizations are widely recognized to meet the need for global standards, albeit not in all sectors, areas of technology, or applications. (In many of these cases U.S. domiciled SDOs fill the need quite appropriately.) The ISO and IEC are European domiciled non-governmental international organizations consisting of *large numbers of national member bodies*. ISO, established in 1947, is made up of the national standards organizations of 102 full-members, each country with a single vote. The IEC was founded in 1906, and national committees from more than 50 individual countries develop its standards. ISO currently has 185 technical committees with wide ranging scope; IEC has 88 committees, focused on primarily electrotechnical issues. There is one joint committee, JTC-1, which focuses on information technology and application. Through ANSI , the United States is active in ISO and IEC, both at the technical committee level and at the policy level.

The technical work of ISO is highly decentralized and is carried out in a hierarchy of about 2,850 technical committees, subcommittees and working groups that are supported by a Central Secretariat based in Geneva, Switzerland. The committees are composed of representatives from industry, research institutes, government authorities, consumer bodies, and international organizations from all over the world. About 30,000 experts participate in meetings each year. The major responsibility for administrating a standards committee is accepted by one of the national standards bodies that make up the ISO membership. ISO standards are developed according to the cardinal principles of international standardization, consensus being one of them. A committee chair assists committee members in reaching consensus. Generally, a consensus will mean that a particular solution to a problem at hand is judged to be the best possible one for international application at that time. The need for a standard is usually expressed by an industry sector that voices this need to its national member body. The member body proposes the new work item to ISO as a whole. Once the need has been recognized and formally agreed, the first phase involves definition of the technical scope of the future standard. This phase is usually carried out in working groups, which are comprised of technical experts from countries interested in the subject matter. Once agreement has been reached on the particular technical aspects that are to be addressed in the standard, a second phase is entered during which countries negotiate the detailed specifications within the standard. This is the consensus-building phase. The final step involves the formal approval of the resulting draft international standard according to the rules of the ISO, following which the agreed-upon text is published as an ISO international standard.

Furthermore, most ISO standards require periodic revision. Factors such as technological evolution, new methods and materials, and new quality and safety requirements may, in time, render a standard out of date. Therefore, ISO has established the general rule that all ISO

standards should be reviewed at intervals of not more than five years. To date, ISO's work has resulted in more than 12,000 International Standards. A list of all ISO standards appears in the ISO Catalogue.

As previously stated there are other bodies that develop international standards including: the International Electrotechnical Commission (IEC), and the International Telecommunications Union (ITU). In addition, Codex Alimentarius of the World Health Organization (WHO), and the International Organization for Legal Metrology (OIML) are bodies whose activities include standards development; but for whom standardization is not necessarily their prime or sole objective. (A Detail description of these organizations is beyond the scope of this paper, but further information can be radily obtained by interested readers.)

4. ISO Technical Committee 85: Nuclear Energy

As we have discussed, the principal technical business of ISO, that of producing international standards, is carried-out by a variety of Technical Committees. In particular, ISO Technical Committee 85 on Nuclear Energy supports the development of international standards on reactor technology. The current composition of TC 85 consists of three subcommittees and two Work Groups. ISO / TC 85, Subcommittee 6 on Reactor Technology (SC 6) is directly responsible for standards-development activities within its associated technical area. (The other TC 85 Subcommittees and Working Groups are SC 2 on Radiation Protection; SC 5 on Nuclear Fuel Technology; WG 1 on Terminology, Definitions, and Symbols; and WG 3 on Dosimetry for Radiation Processing.) The business of SC 6 is broadly focused on all aspects of reactor technology; however, the Subcommittee is presently engaged in the development of standards dealing with decay heat removal in light-water nuclear power reactors, the preparation of technical specification for research reactors, criteria for emergency preparedness at nuclear generating stations, and guidelines dealing with the seismic response of nuclear facility sites, structures, and systems.

Presently, seventeen member bodies participate on ISO / TC 85, these are: Argentina, Austria, Belgium, Bulgaria, Canada, China, France, Germany, Italy, Japan, Russia, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States. New work items to be considered by Subcommittee 6 may be brought before the subcommittee membership by any member of the Subcommittee. However, formal recognition by ISO of a proposed new work item occurs only after approval of the item by affirmative vote from the national member bodies of the participating nations (the so-called P-members). For formal approval, all new work items must meet three acceptance criteria. Firstly, the proposed new work item must be approved by a simple majority of the voting P-members. Secondly, voting P-members accord the work item a market-relevance score ranging from 0 to 25; the average score awarded by the voting P-members must be greater than 15 for the item to receive formal ISO approval. Thirdly, at least five of the P-member nations voting for approval of the new work item must agree to participate in the development of the proposed, new international standard and have nominated, by name, at lease one technical expert from their respective countries who has agreed to serve on a working group that will then be constituted to execute the work of developing the new standard.

4.1 Respective Roles of the International Atomic Energy Agency and ISO

Beyond issues regarding technology proper, an extremely important element of the collective nuclear power enterprise is that of nuclear safety. Safety regulations in the nuclear energy field, as with all regulations, fall not to the jurisdiction of standards development organizations, but, rightly so, to government-sanctioned regulatory bodies operating within national boundaries. Within the international nuclear energy sector, however, the International Atomic Energy Agency (IAEA) has been chartered with jurisdiction over aspects of nuclear safety. The IAEA is a United Nations-authorized international body, with in excess of 100 member states, whose objective is to enhance worldwide safety with regard to the peaceful used of nuclear energy. As such, the IAEA produces so-called "safety standards," which, like all standards, provide technical recommendations, in this case targeted at aspects of ensuring nuclear safety. Often times, however, regulatory bodies of nations adopt select IAEA safety standards, incorporating them into that nation's laws – such standards now carry the force of law.

With two international bodies addressing technology aspects of nuclear electric generation, namely ISO and IAES, there exists the potential for conflicting recommendations to arise. In order to avoid such circumstances, ISO and IAEA issued, in 1981, a memorandum of understanding that defines the boundaries delimiting the scope of each respective agency. The agreement reaffirms the position of IAEA's statute to establish safety standards that provide comprehensive guidance in the areas of safety of nuclear power plants, research nuclear reactors, nuclear fuel cycle activities and facilities, radiation protection, radioactive waste management, and the transport of radioactive material. The work of ISO is considered complimentary to that of the IAEA, and should be directed towards selected nuclear technologies that have world-wide recognition by providing prescriptive, detailed information regarding their application.

5. Conclusions

With over 30 of the world's nations obtaining a portion of their electric power from nuclear generating stations, coupled to an apparently burgeoning market in Asia, there remains great potential for the world market in nuclear-generated electricricity and affiliated services to increase markedly. Accordingly, there exists a concomitant need for international standards addressing nuclear technology to help ensure harmonization among regional nuclear markets. Moreover, as older plants reach the end of their operating service lives, generating capacity will need to be replaced, further enhancing the need for international standards. A smaller, but nevertheless important, consideration is that many of the worlds developed nations devote considerable effort to the operation of test and research reactors, and standards addressing these facilities also fall under the purview of ISO TC 85 / SC 6. Applications of test and research reactors has, in recent times, greatly expanded from more traditional research areas supporting nuclear technology, such as core design, reactor physics, and neutron transport, to the use of neutrons as probes of material properties (nuclear condensed matter physics). New information revealed from these applications has found wide applicability in many areas of science and technology, and will help bolster the test and research reactor market.

A stated previously, the elimination of technical barriers to trade through the promotion of technical consensus, as mediated by international standards and technical agreements, is the best way that we, as a collective society, have devised to ensure equal access to global, free markets. Notwithstanding, in order to take full advantage of the benefits bought about by international standardization, it behooves any nation to participate fully in the international consensus-building process, thereby ensuring that national interests are appropriately represented in the

greater international arena. In this regard, new members are welcome to join ISO / TC 85, Subcommittee 6 and bring to bear their individual skills and expertise to craft the next generation of international reactor-technology standards.

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