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AMERICAN SOCIETY FOR TESTING AND MATERIALS
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Standard Practice for Systematizing the Development of (ASTM) Voluntary Consensus Standards for the Solution of Nuclear and Other Complex Problems[1]

This standard is issued under the fixed designation E 583; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

INTRODUCTION

This guidance document was initiated by a committee[1] of ASTM to help in the development of test methods and other types of standards to assist in solving problems common to a number of committees throughout the Society. It is submitted to ANSI for promulgation beyond ASTM because it appears probable that the techniques and the consensus approach recommended herein could be adapted by other organizations to aid in the management of a variety of problems and long-range projects.

The nuclear power industry needs to know how its materials and systems will perform in the face of the most rigorous combination of environmental conditions encountered in any field of engineering. Every possible limitation of materials and systems in this context must be probed and quantified, then made readily available to both the designer and the regulator. A most efficient way of developing and maintaining procedural criteria, which may be updated as new information becomes available, is through the preparation, uses, and maintenance of standards.

Standards-writing committees, to organize their work programs more systematically, are turning to the matrix approach described in this procedure. Although originated to help solve nuclear problems, the ASTM consensus procedures along with the matrix approach also can be applied to other complex and critical problems, such as health, safety, security systems, energy conservation, fire prevention, and public housing. In some cases the only "standard" involved might be an ASTM recommended guide itself. Here the guide would provide a basis for agreement by all concerned upon the required activities, and resulting publications. Use of the guide will achieve and maintain agreement, keep the project focused upon what is required, what the status of each requirement is, and what the final objectives are—conference(s), publication(s), or standard(s). Using this procedure, the required combinations of committees from ASTM, and other organizations as needed, can be brought to bear on a series of coordinated, long-term voluntary programs. This will help solve major, even national objectives with the priority of the cooperative efforts remaining clearly defined until the projects are completed.

A guideline document such as described herein, or a family of interrelated documents for a complicated project, which have been adopted as ASTM standards, become tools used to help manage the development of the standards needed for the project. The initial or master guidelines or families of such documents for a complex program would allow direct and unique input into the standards development process and the research associated therewith by the managements of the governmental, industrial, or other organizations concerned with directing the effort. An early objective of the standardization process contemplated here would be to divide the problem into manageable units and a technology breakdown structure so that the consensus mechanism can be applied to the establishment of guideline (matrix) approaches for the respective elements or subdivisions of the problem. In any complex matrix program standards developed by private bodies or government agencies will already exist. These must be referenced and integrated into the development to avoid duplication of effort and to determine whether additional new work or refinement is required for the project at hand. As the missing standards are completed by the responsible committees, or technology advances, or the urgency of elements change, revisions to an ASTM recommended guide will keep it up to date. In this way all will have the advantage of agreed upon, yet adjustable, objectives for accomplishment.

Complex projects or problems may involve the cooperation of a number of committees, a number of standards, and possibly areas that will be amenable to standardization only after

[1] This practice is under the jurisdiction of ASTM Committee E-10 on Nuclear Technology and Applications and is the direct responsibility of Subcommittee E10.10 on Matrix Approaches to Standards for Nuclear Systems Technology.

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research. Within ASTM, some committees might use one or more guideline matrix approaches as the basic mechanism for planning and managing their future publications/standards work. Use of these approaches might help overcome the interruption of continuity and redirection of projects that might occur when changes are made in subcommittee and main committee leadership.

1. Scope

1.1 This practice covers matrix approaches applicable to a broad range of problems.

1.2 This practice describes how the ASTM system for developing and managing full consensus standards, in which individual ASTM committees usually are involved, can be coupled with matrix approaches to provide agreed-upon, yet adjustable objectives for voluntary accomplishment. This would apply irrespective of the time required, the number of ASTM committees concerned, or the complexity of the issues involved.

1.3 For the solution of multicommittee problems of a conventional nature, this procedure contemplates that one ASTM committee will assume the responsibility for developing and maintaining the guide covering the master matrix.

1.4 When a new Society committee is formed to handle a problem beyond the scope of the previously available ASTM committee, it should try to use this matrix approach to consolidate, refine, and manage its approach to problems agreed upon during organizational meetings.

1.5 This document will be changed to add references to typical examples of matrix approaches as these ASTM recommended guides are adopted by the Society. Whenever indicated, this procedure should be revised to include excerpts from guideline documents that illustrate new applications for this technique.

1.6 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

C 559 Test Method for Bulk Density by Physical Measurement of Manufactured Carbon and Graphic Articles[2]

C 651 Test Method for Flexural Strength of Manufactured Carbon and Graphite Articles Using Fan-Point Loading at Room Temperature[2]

C 695 Test Method for Compressive Strength of Carbon and Graphite[2]

C 781 Practice for Testing Graphite and Boronated Graphite Components for High-Temperature Gas-Cooled Nuclear Reactors[2]

E 228 Test Method for Linear Thermal Expansion of Rigid Solids With a Vitreous Silica Dilatometer[3]

E 584 Recommended Guide for Developing the (ASTM) Voluntary Consensus Standards Required to Help Implement the National Energy Plan[4]

E 669 Master Matrix for Nuclear Fuel Cycle Standards[5]

E 706 Master Matrix for Light-Water Reactor Pressure Vessel Surveillance Standards[4]

3. Summary of Practice

3.1 In dealing with a complex long-range standards development project, a family of integrated matrix guides will be needed.

3.1.1 The initial or master matrix guide for a complex project probably would be a relatively simple document. It should identify the major subdivisions of the project, state that each subdivision will be the subject of a subordinate matrix guide, indicate the priority of each section, and identify the committee(s) responsible. Upon completion of the ASTM approval procedures, this master matrix would be published as an ASTM standard.

3.1.1.1 As a guide for one of the major subdivisions is approved as an ASTM standard, the master guide would be editorially revised to include the ASTM designation for the subordinate guide. This procedure would be repeated as each remaining document is completed for one of the major subdivisions.

3.1.2 To begin the development of standards or guides for a series of complex projects, an initial or master matrix guide consisting of chart(s) with appropriate words would be developed by a lead committee with the help of the others involved. Recommended Practice E 584 and Fig. 1 show how this technique is used by Committee E-10 to aid the ASTM committees in helping to implement the National Energy Plan.

3.1.3 A considerable more detailed master guide of chart(s) would be used to lead off a specific but complex project. Figure 2 shows the coordinates for a possible initial standards matrix chart for a nuclear power plant which would be one of the elements of the National Energy Plan discussed in 3.1.2. The potential for a guide or standard exists for each intersection of coordinates in Fig. 2, and the end product would be a list of proposed guides or standards grouped in a logical manner. Development of the coordinates for Fig. 2 to cover standards for the construction of a plant and the production of products would proceed as follows:

3.1.3.1 The horizontal coordinates for Fig. 2 identify relevant aspects of the plant or facility. The facility is separated into two broad areas and several subgroups according to the following philosophy:

(*1*) Determine those items which are applicable to site support (4.1) (location, geography, hydrology, natural phenomena, etc).

(*2*) Determine those items related to plant support (1.2):

(*a*) Consider systems and components related to primary plant operation.

(*b*) Consider systems and components that primarily service the operation.

(*c*) Consider structures and materials that make up the structures that provide physical support for operation and service (steel and concrete structures, component supports, pile foundations, and earth structures).

[2] *Annual Book of ASTM Standards*, Vol 15.01.
[3] *Annual Book of ASTM Standards*, Vol 14.02.
[4] *Annual Book of ASTM Standards*, Vol 12.02.
[5] *Annual Book of ASTM Standards*, Vol 12.01.

	Fossil Fuels								Solar				Conservation									Fission Reactor Development								
																						Breeder				Converter				
																										(LWR)				
	Direct-coal utilization	Magnetohydrodynamics	Enhanced oil and gas recovery	Coal gasification	Coal liquefication	Oil shale	Advanced research and supporting technology	Demonstration plants	Fuels from biomass	Solar electric applications	Solar heating and cooling	Geothermal	Buildings	Consumer products	Electric conversion efficiency	Electric power transmission and distribution	Energy storage	Industrial energy efficiency	Conservation in transportation	Interprogram applications	Fusion	Liquid metal-cooled fast breeder (LMFBR)	Gas-cooled fast breeder (GCFR)	Light water breeder (LWBR)	Molten salt breeder (MSBR)	Pressurized water (PWR)	Boiling water (BWR)	High-temperature gas-cooled (HTGR)	Very high-temperature (VHTR)	Direct-cycle high temperature (DCHTR)
Definition of functional characteristics																														
Function																														
Performance versus conditions																														
Definition of conditions																														
Provision of achieve function																														
Analysis, design, and construction																														
Operation and maintenance																														
Decommissioning																														
Additional miscellaneous requirements																														
Quality assurance and reliability																														
Design control																														
Process or configuration qualification																														
Product control																														
Construction control																														
Operation control																														

CODE: ⊡ Applicable ☐ Not Applicable

NOTE—Each potential area of standards need is to be considered for each element of the National Energy Plan by the responsible committee.

FIG. 1 Matrix on Potential Needs for (ASTM) Standards Required to Help Implement the National Energy Plan

(*d*) Consider requirements for personnel associated with the plant (people duties for construction, operation, and maintenance).

3.1.3.2 The vertical coordinates for Fig. 2 identify the content of the needed guides or standards. The detailed outline of the vertical potential content coordinates for Fig. 2 are developed from the following general approach:

(*1*) Determine the function and desired performance under stated conditions (definition of functional characteristics).

(*2*) Determine the set of criteria that, if followed, will provide some degree of assurance of achieving the stated function (provision to achieve function).

(*3*) Determine methods and procedures to assure that you accomplished that which was considered necessary (quality assurance and reliability).

3.1.3.3 The intersections of the coordinates for the matrix shown in Fig. 1 indicate the potential need for development of guides or standards. The major intersections probably indicate the need for subordinate master matrix guides. These would be the documents that would develop consensus approval for basic aspects of the standards work required. The prose for such a master guide, which usually would incorporate a matrix chart, would evaluate each listed system, service, component, or part with respect to definition of functional characteristics, provisions to achieve function, and quality assurance and reliability. The treatment for each title within the guide would include the major content of the subordinate guide or standard, cover the priority or need for the document, and identify the committee standard, cover the priority or need for the document, and identify the committee that will develop the item. From Fig. 2 it is evident that ASTM committees require design parameters before standards for materials methods and specifications can be developed. Conversely, the same information is required to evaluate and determine whether existing standards are appropriate or applicable to a condition represented by the specific complex project under consideration.

3.2 When the matrix requirements cover a specific project element and are sufficiently detailed to deal with the need for individual standards, such as test methods, the process would follow the pattern of the matrix chart and words shown, for example, in Practice C 781 (Fig. 3 and Appendix X1) for a guide to cover development of the methods. In this case a practice covers the development of test methods for graphite components for high-temperature gas-cooled nuclear reactors. A guide for use at this level of a project, and concerned with end-product standards should be in accordance with 3.6.

3.2.1 When an important individual standard or guide is known to be required, work on it should be undertaken without delay for completion or revision of a guide or matrix for the project. Such a situation can be expected to occur as work on a matrix approach begins.

3.3 A complex problem, large or small, sometimes might

	Site	Plant			
	Site Overall Site Specific Aspects	Plant Overall plant	Powerplant Systems and Components Primary System Overall Primary Systems Reactor Coolant Reactor Vessel Valves Pumps Piping Other Vessels Steam Generator (Tube Side) Shielding Mechanical Components Insulation Residual Heat Removal Reactor Core Isolation Cooling Main Steam Isolation Valve Sealing System (BWR)	Secondary and Steam System Overall Secondary System Steam Generator (Shell Side) Valves Pump Piping Turbine Condenser	Reactor Internals Overall Internals Core Support and Internal Structures Fuel Assemblies Control Rods Control Rod Drives
A. Definition of Functional Characteristics					
a. Function					
1. Safety Class Relationship					
2. Contain Fluids					
3. Maintain Certain Condition					
4. Continue Operation					
b. Performance vs. Conditions					
1. Loading Combinations					
2. Operational Behavior					
c. Definition of Conditions					
1. Definition of Events					
2. Magnitude of Event					
3. Type of Load from Event					
4. Data Requirements					
B. Provision to Achieve Function					
a. Analysis, design, and construction					
1. Structural					
2. Environmental Compatibility					
3. Fluid Flow Constraints					
b. Operation and Maintenance					
1. Reliability					
2. Operability					
3. Removal					
4. Interaction with Function or Other Operation					
c. Decommissioning					
1. Isolation					
2. Accessibility					
3. Redundancy					
d. Additional Misc. Requirements					
1. Design, Process, or Configuration Requirements					
2. Layout					
3. Redundancy Systems					
4. Sharing					
C. Quality Assurance and Reliability					
a. Design Control					
1. Design Method and Procedures					
2. Materials Selection					
b. Process or Configuration Qualification					
1. Preoperational Testing					
2. Analytical Evaluation					
3. Qualification Testing					
c. Product Control					
1. Performance Capability					
2. Verification and Checking Procedures					
3. Quality Control					
d. Construction Control					
1. Proper Materials Used					
2. Correct Assembly Procedures					
3. Equipment Storage					
4. Quality Control					
e. Operation Control					
1. Preservice Testing (Baseline)					
2. Monitoring					
3. Inservice Inspection					
4. Quality Control					

FIG. 2 Possible Matrix on Potential Needs for Standards or Guides for a Nuclear Power Plant (Courtesy of Engineering Standards Branch, U. S. Nuclear Regulatory Commission)

	Plant			
	Engineered Safety Features Overall Engineered Safety Features Containment Systems Emergency Core Cooling System Habitability Systems Fission Product Removal & Control Class 2 & 3 Fluid Systems Other Engineered Safety Systems	Containment Structure Overall Containment Structures Concrete Containment Steel Containment Instrumentation & Control Electric Power	Service Facilities Fuel Handling Fuel Storage Radioactive Waste Water Systems Process Auxiliaries Heating and Ventilating	Other Auxiliary Systems Fire Protection Communications Fuel Oil Storage & Transfer Structures Steel Structures Concrete Structures Component Supports Pile Foundations Earth Structures Cooling Ponds Personnel
A. Definition of Functional Characteristics a. Function 1. Safety Class Relationship 2. Contain Fluids 3. Maintain Certain Condition 4. Continue Operation b. Performance vs. Conditions 1. Loading Combinations 2. Operational Behavior c. Definition of Conditions 1. Definition of Events 2. Magnitude of Event 3. Type of Load from Event 4. Data Requirements				
B. Provision to Achieve Function a. Analysis, design, and construction 1. Structural 2. Environmental Compatibility 3. Fluid Flow Constraints b. Operation and Maintenance 1. Reliability 2. Operability 3. Removal 4. Interaction with Function or Other Operation c. Decommissioning 1. Isolation 2. Accessibility 3. Redundancy d. Additional Misc. Requirements 1. Design, Process, or Configuration Requirements 2. Layout 3. Redundancy Systems 4. Sharing				
C. Quality Assurance and Reliability a. Design Control 1. Design Method and Procedures 2. Materials Selection b. Process or Configuration Qualification 1. Preoperational Testing 2. Analytical Evaluation 3. Qualification Testing c. Product Control 1. Performance Capability 2. Verification and Checking Procedures 3. Quality Control d. Construction Control 1. Proper Materials Used 2. Correct Assembly Procedures 3. Equipment Storage 4. Quality Control e. Operation Control 1. Preservice Testing (Baseline) 2. Monitoring 3. Inservice Inspection 4. Quality Control				

FIG. 2 Possible Matrix on Potential Needs for Standards or Guides for a Nuclear Power Plant (Courtesy of Engineering Standards Branch, U. S. Nuclear Regulatory Commission)—*Continued*

Test Methods for Boronated Graphite Components	Compacts			Side Shield Blocks	Reserve Shutdown Compacts
	Control Rod	Lumped Burn-able Poison	Upper and Lower Shield		
Bulk density	C 559[C]	C 559[C]	C 559[C]	C 559[C]	[A]
Linear thermal expansion	E 228[B]	E 228[B]	E 228[B]	[A]	[A]
Mechanical properties:					
Compressive strength	C 695[B]	C 695	C 695[B]	C 695[B]	[A]
Flexural strength	[A]	[A]	[A]	C 651	[A]
Impact performance	[A]	[A]	[A]	[A]	[D]
Chemical properties:					
Catalytic impurities	[D]	[D]	[D]	[A]	[B]
Sulfur concentration	[D]	[D]	[D]	[D]	[D]
Hafnium concentration	[A]	[D]	[A]	[A]	[A]
Relative oxidation rate	[D]	[D]	[D]	[D]	[A]
Boron analyses:					
Total boron	[D]	[D]	[D]	[D]	[D]
Boron as oxide	[D]	[D]	[D]	[D]	[D]
B_4C particle size	[D]	[A]	[B]	[A]	[A]
Boron in graphite crystals	[D]	[D]	[A]	[A]	[A]

[A] There is no identified need for determining this property.
[B] Modification of this method is required. Refer to Section 10 of Practice C 781 for details.
[C] Additional test methods are required. Refer to Section 10 of Practice C 781 for details.
[D] New test methods are required. Refer to Section 10 of Practice C 781 for details.

FIG. 3 Matrix on ASTM Standard Test Methods for Boronated Graphite Components for a High-Temperature Gas-Cooled Nuclear Reactor
(See Practice C 781 included as an example herein.)

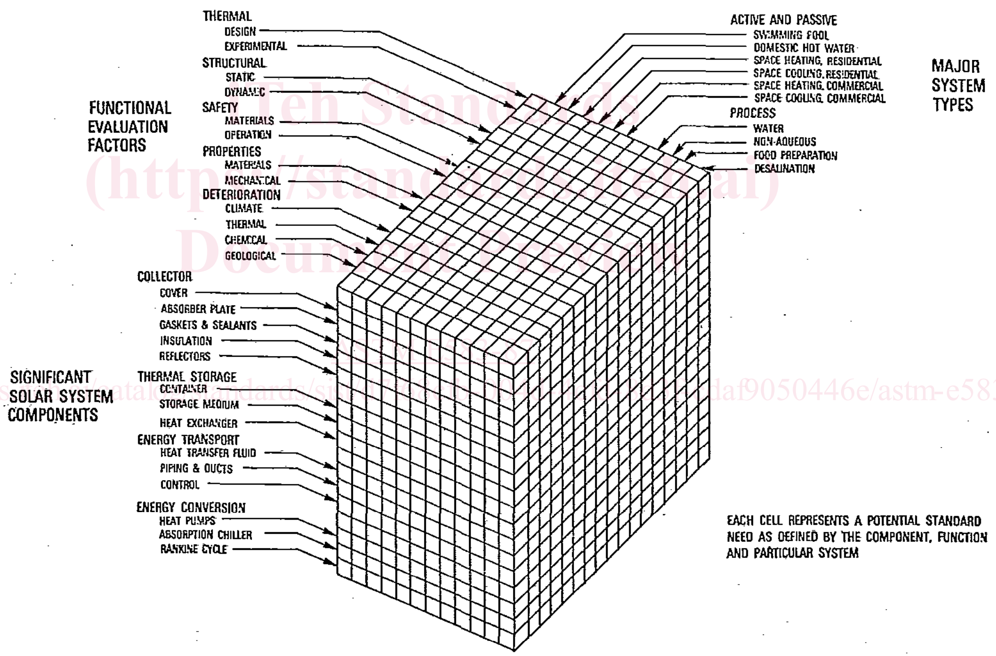

FIG. 4 Application of Three-Dimensional Matrix for Identifying Potential Solar Standards Needs
(From NBS and ASTM Committee E-44 on Solar Energy Conversion)

be understood and analyzed more readily by the application of a three-dimensional matrix. Figure 4 illustrates such a three-dimensional approach for identifying potential needs for standards for solar heating and cooling applications. Figure 5 illustrates such a three-dimensional approach applied to a problem of materials availability. The modified decimal organization of an ASTM standard with topics subordinate to one another will accommodate the systematic "cell by cell" analysis, and provide the explanation and documentation that is necessary to accomplish the objectives for which a three-dimensional matrix was developed.

3.4 In any complex matrix program many standards will already exist. These must be referenced and intergrated into the development to avoid duplication of effort and to determine whether additional new work or refinement is required for the project at hand. For example, in the case of a nuclear facility, many of the characteristics shown in the sample matrix, Annex X2.1, Figs. X2.1 and X2.2, are also covered by the U.S. Nuclear Regulatory Commission "Regulatory Guides." Existing documents such as ASTM, ASME, and ANSI, which are endorsed or recommended in these NRC Regulatory Guides, should be integrated into the program. Conversely, standards should be considered to cover any areas for which government documents, such as Regulatory Guides, were issued before suitable standards were available for endorsement.