U.S. Department of Commerce

National Bureau of Standards

NBS Monograph 165

An Institutional Plan For Developing National Standards

With Special Reference to Environment, Safety, and Health

NATIONAL BUREAU OF STANDARDS

The National Bureau of Standards[1] was established by an act of Congress on March 3, 1901. The Bureau's overall goal is to strengthen and advance the Nation's science and technology and facilitate their effective application for public benefit. To this end, the Bureau conducts research and provides: (1) a basis for the Nation's physical measurement system, (2) scientific and technological services for industry and government, (3) a technical basis for equity in trade, and (4) technical services to promote public safety. The Bureau's technical work is performed by the National Measurement Laboratory, the National Engineering Laboratory, and the Institute for Computer Sciences and Technology.

THE NATIONAL MEASUREMENT LABORATORY provides the national system of physical and chemical and materials measurement; coordinates the system with measurement systems of other nations and furnishes essential services leading to accurate and uniform physical and chemical measurement throughout the Nation's scientific community, industry, and commerce; conducts materials research leading to improved methods of measurement, standards, and data on the properties of materials needed by industry, commerce, educational institutions, and Government; provides advisory and research services to other Government agencies; develops, produces, and distributes Standard Reference Materials; and provides calibration services. The Laboratory consists of the following centers:

Absolute Physical Quantities[2] — Radiation Research — Thermodynamics and Molecular Science — Analytical Chemistry — Materials Science.

THE NATIONAL ENGINEERING LABORATORY provides technology and technical services to the public and private sectors to address national needs and to solve national problems; conducts research in engineering and applied science in support of these efforts; builds and maintains competence in the necessary disciplines required to carry out this research and technical service; develops engineering data and measurement capabilities; provides engineering measurement traceability services; develops test methods and proposes engineering standards and code changes; develops and proposes new engineering practices; and develops and improves mechanisms to transfer results of its research to the ultimate user. The Laboratory consists of the following centers:

Applied Mathematics — Electronics and Electrical Engineering[2] — Mechanical Engineering and Process Technology[2] — Building Technology — Fire Research — Consumer Product Technology — Field Methods.

THE INSTITUTE FOR COMPUTER SCIENCES AND TECHNOLOGY conducts research and provides scientific and technical services to aid Federal agencies in the selection, acquisition, application, and use of computer technology to improve effectiveness and economy in Government operations in accordance with Public Law 89-306 (40 U.S.C. 759), relevant Executive Orders, and other directives; carries out this mission by managing the Federal Information Processing Standards Program, developing Federal ADP standards guidelines, and managing Federal participation in ADP voluntary standardization activities; provides scientific and technological advisory services and assistance to Federal agencies; and provides the technical foundation for computer-related policies of the Federal Government. The Institute consists of the following centers:

Programming Science and Technology — Computer Systems Engineering.

[1]Headquarters and Laboratories at Gaithersburg, MD, unless otherwise noted; mailing address Washington, DC 20234.
[2]Some divisions within the center are located at Boulder, CO 80303.

An Institutional Plan For Developing National Standards

With Special Reference to Environment, Safety, and Health

Bruce W. Steiner

Center for Materials Science
National Bureau of Standards
Washington, D.C. 20234

U.S. Department of Commerce
Juanita M. Kreps, Secretary
Luther H. Hodges, Jr., Under Secretary
Jordan J. Baruch, Assistant Secretary for Science and Technology

National Bureau of Standards
Ernest Ambler, Director

Issued September 1979

Library of Congress Catalog Card Number: 79-600116

National Bureau of Standards Monograph 165
Nat. Bur. Stand (U.S.), Mono. 165, 24 pages (Sept. 1979)
CODEN: NBSMA6

U.S. GOVERNMENT PRINTING OFFICE
WASHINGTON: 1979

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402
Stock No. 003-003-02094-0

SUMMARY

The National Bureau of Standards was asked in 1977 to design a comprehensive agency-wide standards plan for the Energy Research and Development Administration. This plan was to provide assurance that all essential non-nuclear energy-related, environmental, safety, and health (ES&H) standards would be available to the private sector when new energy technologies were ready for commercialization. The development of such standards in the United States is a subset of the development of technological standards.

The resulting plan, presented here, thus may be applicable also to other technological standards, those important to private companies as well as to a variety of Federal and State agencies. Such standards consist of two basic types: "limit standards," which establish system performance criteria and "compliance measurement standards," which establish methods for the demonstration of compliance with "limit standards."

The ES&H standard development process described herein differs from other technical standards processes primarily in (1) the close relationship that it bears to the identification and quantification of hazards and also, (2) the necessity for systematic evaluation of compliance. The "ES&H standards system" addressed in this report covers all four of these elements: (1) Hazards, (2) Limit Standards, (3) Evidence of Compliance, and (4) Compliance Measurement Standards.

The unabridged version of this standards development process contains 39 discrete steps, each of which consists of intermediate stages. These are described here in the context of 10 essential standards management functions which have been described elsewhere. Some essential components in a comprehensive system, such as the voluntary standards bodies, already exist.

However, to carry out many of the other functions effectively, new organizations would be required. Some of these will necessarily operate nationally, while others will be required internally within each affected agency. Although a substantial effort would be essential to implement this plan, the proposed structure effectively operated would provide documented assurance that the necessary standards will be developed in a reliable and economical fashion. Moreover, the proposed structure achieves this economy by utilizing existing institutions without basic changes and provides others to supplement them for the new functions now being demanded for the first time. The operation of the entire process is described in terms of a hypothetical example.

ACKNOWLEDGMENT

A number of DoE and NBS colleagues have contributed actively and extensively to development of the ideas in this report. In the Department of Energy, the assistance of George Dix and Robert Poe was essential to the general form and detailed presentation of the planning. At the National Bureau of Standards, the guidance and encouragement of Howard Sorrows and Wayne Cassatt were essential to the entire effort. Extensive conversations with John Wachtman, Jr., Elio Passaglia, and James Leiss also played an important role at critical junctures in the thinking. The author, however, is entirely responsible for any deficiencies in the logic or conclusions that may be formed.

CONTENTS

AN INSTITUTIONAL PLAN FOR DEVELOPING NATIONAL STANDARDS

With Special Reference to Environment, Safety, & Health

Bruce W. Steiner

This plan was commissioned to provide a framework for the development of all essential non-nuclear energy-related, environmental, safety, and health (ES&H) standards for the private sector to coincide with the commercialization of new energy technologies. The development of such standards in the United States is a subset of the development of technological standards. Such standards consist of two basic types: "limit standards," which establish system performance criteria and "compliance measurement standards," which establish methods for the demonstration of compliance with "limit standards." The system addressed in this report encompasses four basic elements: (1) Hazards, (2) Limit Standards, (3) Evidence of Compliance, and (4) Compliance Measurement Standards. The unabridged version of the standards development process contains 39 discrete steps, each of which consists of intermediate stages. These are described here in the context of 10 essential standards management functions. Some essential components in a comprehensive system, such as the voluntary standards bodies, already exist. However, to carry out many of the other functions effectively, new organizations would be required. The operation of the entire process is described in terms of a hypothetical example.

Key words: energy standards; environmental standards; safety and health standards; standards development.

I. Introduction

The Energy Research and Development Administration (ERDA) commissioned the National Bureau of Standards (NBS) in 1977 to prepare a comprehensive standards development plan. This plan was to be designed to provide assurance that the introduction of new energy technologies would not be held up by: (1) the absence of environmental, safety, and health (ES&H) standards for the private sector nor (2) the inability in the private sector to demonstrate compliance with existing standards.

The resulting plan is presented here in the form of a general foundation for guiding development of specific Agency activity. It is based on extensive conversations with the management of the ERDA Division of Operational and Environmental Safety, many technology divisions within ERDA, as well as the experience of NBS staff in the various phases of technological standards development.

The plan is built on three key principles. The first is the basic recognition that the standards to be developed under it must play a new anticipating role for technical standards [1].* In some instances this role involves the use of standards to stimulate the development of technology. In others, especially in environment, safety, and health, standards will guide the course of the

* Numbers in brackets refer to references listed on page 17.

development of technology. In both roles, standards will also provide an important means for the transfer of technology within the private sector.

The second principle is that the voluntary standards groups, essentially unchanged, must continue to play their critical role at the heart of the standards system in achieving consensus on specific standards. The plan, therefore, assumes the continued vitality both of the voluntary standards groups and of technology division activity and builds upon them as critical steps in the actual development of specific standards. Technology division activity cannot be bypassed. Only by exception and at the cost of additional burdens elsewhere in the system can the voluntary standards groups be circumvented. In order for the voluntary standards groups and the technology divisions to continue to play their accustomed role in dealing with expanded needs, however, auxiliary institutions will need to be established in each agency or company [2].

The third principle is that the system called for be as simple as possible consistent with the achievement of the stated goals.

The plan is constructed with two sets of elements. The first set is a description of the complete ES&H standards development process, consisting of 39 major steps as they presently exist. Many of these, however, have not previously been recognized as part of a formal standards system. The second set is a group of 10 essential functions for a comprehensive standards system, a set described in a previous paper [1]. This group is the smallest function set that provides a *a system with all characteristics required by the expanded role now expected of ES&H standards.*

The resulting plan is very general in nature and can be adapted with little modification to the development of a wide variety of technical standards either by a governmental agency or a firm in the private sector.

II. Glossary

Limit Standards: Criteria that specify limits, performance requirements for subsystems, systems or components, or work practices.

Compliance Measurements Standards: Accepted procedures that establish an approved method for demonstrating compliance with a limit standard. In general, three elements must be included: (1) a physical reference measurement standard; (2) a physical reference measurement technique, and (3) a statistical protocol.

Voluntary Consensus Standards: Standards developed by recognized consensus procedures designed for voluntary compliance.

Specifications: Performance and design criteria (regulations) issued by the Federal Government. These are increasingly being developed cooperatively through the voluntary consensus standards system. The responsibility for such a regulation rests on the regulatory agency, however, and not on the voluntary consensus standards body that participates.

III. Standards Development Building Blocks

A. Basic Structural Elements of American ES&H Standards Development

The development of environmental, safety, and health-related standards takes place in a context that inevitably influences the performance of the standards system. The activity that initiates standards development (for example, the perception of a potential hazard) and the institutions that monitor compliance with standards both influence the character of standards actually developed. Therefore, the system for developing ES&H standards needs to be planned in concert with these related activities. The ensemble of all of these activities, the "Environmental, Safety, and Health Standards System" is addressed in the plan that follows. The plan can readily be generalized to cover most or all technology standards.

The entire ES&H system (fig. 1) is driven by the perception of ES&H factors, "hazards." The primary standards system response to this driving force is the establishment of "limit standards," codes of accepted practice. ES&H limit standards restrict the exposure of workers in the technology and of the general public to the identified hazards. Evidence that the limit standards are performing their specified task effectively is obtained through "evidence of compliance." Such evidence consists of data that demonstrate conclusively that each limit standard is restricting exposure to a hazard in the manner intended. Reliable evidence of compliance is generally based on "compliance measurement standards." Such standards consist of: (1) reference physical measurements standards, (2) reference measurement techniques, and (3) reference measurement statistical protocols. All three elements are necessary to assure essential comparability of the evidence obtained. Without such comparability effective remedial action cannot be instituted. Thus, only with all three elements can reliable environmental, safety, and health performance be assured as a matter of course.

B. Major Standards Development Milestones

The products of the two standards development processes involved, one for limit standards and the other for compliance measurement standards, play distinctly different roles in support of the environment, health, and safety. Nevertheless, the internal structure of the two systems is essentially identical. Common institutions are also frequently involved.

Each of these standards development processes has four similar major milestones (fig. 2): (1) problem identification, (2) development of a technical solution, (3) development of a voluntary standard, and (4) development of a government specification. The first two steps have not generally been considered part of a standards system. Institution standards planning must now incorporate them, however, if it is to assure development of proper standards on time. Moreover, the latter two steps have not always been sequential. Now, it is increasingly important that they be provided typically in the order identified if the public is to be reassured.

More specifically, the four limit standards milestones are:

1. Identification of specific potential limit standards.
2. Resolution of technical questions concerning specific hazards.
3. Development of voluntary limit standards.
4. Development of limit specifications.

The corresponding compliance measurements standards milestones are:

1. Identification of measurement standards required for compliance with established limit standards.
2. Development of reference physical measurement techniques, reference physical standards, and statistical protocols.
3. Development of voluntary compliance measurement standards.
4. Development of compliance measurement specifications.

As an illustrative example for these milestones, let us consider the development of hypothetical NO_2 emission standards. The first milestone for the limit standards system would be the perception that it might be desirable to limit the emission of NO_2 into the atmosphere. The second milestone would be the evidence that NO_2 of a given concentration was hazardous to health. The third milestone might be a consensus ANSI standard limiting the emission of NO_2 to a stated level. The last limit milestone might be a Federal specification limiting the NO_2 emission of a given device purchased with Federal funds, such as an automobile or power plant.

The following compliance measurement standard milestones are associated with the development of our hypothetical NO_2 limit standards. The first is the recognition that demonstration of compliance with the NO_2 emission limit specification requires both a reference physical measurement method for field use and appropriate reference physical measurement standards. The second milestone would be the development (or verification) of such a method and physical standard. The third milestone might be a consensus standard developed by ASTM and incorporating the preceding technical information. Finally, the consensus standard would be transformed into a governmental specification for use in contracts.

As each of these milestones is passed, there are three possible options: (1) to move on toward the next milestone; (2) to bypass the next milestone; and (3) to postpone further standards development until critical barriers are removed. The remainder of this paper describes the operation of a system dealing with all of these options. When either of the first two options is exercised, the system goes continuously to completion. The status of those cases that are postponed (option 3) reverts to that of cases for which standards development has not been initiated. In both latter situations, those for which standards development has not been initiated and those for which it is postponed, records must be kept to enable periodic reassessment and reestablishment of priorities. Then, when new information raises the priority of a potential standard to a sufficiently high level for development to begin, the development process is started. Data obtained during any previous attempt at standards development can thus be utilized in any later renewal of development activity and need not be wasted.

C. Critical Standards Support Activities

The timely achievement of the standards milestones depends critically upon certain support activity. This activity, like the milestones, also is generically common to the two standards processes (fig. 3): (1) Research and development are important, particularly between the first and second milestones. (2) Field verification of the crucial technical step can avoid wasted effort in the development of a voluntary standard. (3) Field test of this consensus standard will provide for a more satisfactory mandatory specification because its essential characteristics have been proven. (4) Finally, the specification of protocols for the demonstration of compliance is the last stage in a satisfactory standards development process.

In the development of limit standards, a wide variety of research and development is necessary. For example, the development of biological screening techniques is basic. Development of the understanding of the physical and chemical fate of reactive molecules in the atmosphere and in water—research from chemical reactions to "plume" behavior—is important if naive environmental standards are to be avoided. Deeper understanding of the behavior of reaction vessel materials in new temperature and/or pressure ranges will be required. After the key technical questions such as these are resolved, but before a voluntary limit standard is created, the key results constituting the resolution of the technical question should be confirmed in a second laboratory. Without this "field verification," spurious results may get enshrined in standards that would prove at the least very embarrassing. In more serious cases they could prove either needlessly expensive or irresponsibly lax. Without the field testing of a voluntary limit standard, ineffective or unnecessarily restrictive voluntary standards could be incorporated in far more damaging Federal specifications. Finally, the development of a suitable compliance reporting procedure assures a minimal, uniform disruption for all involved in technically detailed procedures.

The technical disciplines supporting the development of compliance measurement standards differ substantially from the disciplines supporting the development of limit standards. The research and development required for compliance standards are in the field of physical measurement: the determination of reliable means to measure potential pollutants, structural material characterization, economical and reliable noise measurement technology, etc. Field verification of new measurement technology as it is developed paves the way for the economical and yet satisfactory design of consensus compliance measurement standards. Similarly, field testing of the voluntary compliance measurement standards prepares the way for development of a satisfactory Federal compliance measurement specification. Finally, a series of statistical measurement protocols is required to support compliance measurements that are both comprehensive and economical. Generic statistical tools need to be established because of important differences between regulatory measurements and other systematic measurements, either quality assurance measurements or research measurements.

The hypothetical example of potential NO_2 standards can be extended to illustrate these support activities. The development of NO_2 emission limit standards will depend on the availability of economical screening techniques that answer the questions, "At what level is exposure to NO_2 harmful?" and "How harmful is it at this level?" The regulation of NO_2 emissions would depend on the answer to other questions as well: "How does NO_2 react in the atmosphere?", and "How widely is a given amount of NO_2 released at a given point likely to be distributed?" Key answers to such questions need to be verified in a second laboratory. The cost of control is an important additional factor to be considered in establishing a consensus limit. Both voluntary NO_2 standards and government specifications for NO_2 emissions can be established if time permits both. Before the development of a Federal specification, however, the efficacy of the voluntary standards should be field tested in order to avoid costly mistakes. Finally, a compliance report format must be developed.

Control of NO_2 to specific limits requires reliable procedures to monitor emissions by means of physical measurements. A reference NO_2 measurement standard must be established, along with the validity of the measurement techniques that are likely to be employed with the standard. The establishment of specific cost-effective measurement technology may rest on the exploitation of new technical opportunities such as remote sensing. Whatever technique is ultimately to be employed for NO_2, it cannot be considered to be reliable until it is verified in the field. Similarly, a resulting voluntary standard cannot be incorporated in a Federal specification until its performance "on line" has been tested in the field. Finally, a given test procedure for NO_2 cannot be economically utilized until appropriate statistical designs for measurement protocols have been introduced.

At this point, optimum emission limits and the means for demonstrating compliance with them are complete. The full procedure, although simple in concept, can be prolonged in realization. Both the large number of steps and the large number of those involved in many of the individual steps can make the process a lengthy one.

D. System Design Considerations

The 16 stages of the full standards development process outlined in the two preceding sections call for initial attention to three important issues.

First, as many stages as possible must be bypassed where they can be omitted without impeding the ultimate effectiveness of the entire system. Systematic bypass decision points must, therefore, be established to permit reliable determination of those steps that can safely be omitted in the development of a given standard. Assurance that the omission of these steps has not degraded the total system performance must be obtained.

Second, the management of the various stages must be invested in institutions that will guide each stage with the required expertise. Both economy of motion and expert judgment will be required. A variety of talents will be called for as well as varying degrees of internal agreement within the agency [2]. Thus, a variety of internal organizations is called for, with each playing a distinct role.

Finally, and certainly most important, the establishment of a system of priorities for the development of specific standards will ultimately decide the success of the entire system [3]. At a total cost of $200,000 to $20,000,000 for an average standard, the system will not be able to produce all potential standards. If important standards are not developed, the system will clearly fail to provide the required assurance of hazards mitigation. On the other hand, if relatively unimportant standards are attempted, the system will fail to develop all urgently needed standards in an expeditious manner. A system that attempts too much will succeed at little or nothing. Early definition of priorities is crucial.

IV. The Full Standards Development Process

The incorporation of bypass decision points in the system structures shown in figures 1-3 leads to a comprehensive 39-stage standards development system. Although this represents a substantial streamlining of the present system from start to finish, the bypass decision points will permit still further shortening of the development process for specific standards, given appropriate judgment.

This system is shown in figure 4, in which the color coding of the preceding figures is preserved. Thus, the initial stage dealing with hazards is shown in red. The critical evidence of compliance is shown in blue-green. In between, the two standards development systems are shown with the four major milestones in each shown in black and the four critical support stages of each shown in yellow-green. The bypass decision points are indicated in yellow. These stages will be described after the management functions and organizations have been delineated in the next chapters.

V. Essential Standards Management Functions

The table reviews 10 specific management functions that must be exercised in a standards development system [1]. Four of the 10 standards management functions are intrinsically national in scope and can cover a wide variety of technologies. The other six will necessarily have to be fulfilled by any institution (Federal agency or private company) with a major interest in particular standards, such as the Department of Energy. Of these six institutional functions, three provide specific types of internal coordination and three provide specific system support. Organizations to carry out these functions are described in the next chapter.

A. National Functions

1. Consensus Generation

Existing standards development has focused on the generation of consensus. This restricted focus has been possible first because of the former reactive nature of standards [1] and second because of the earlier primary importance of commercial standards. Those most actively concerned, usually those most directly affected, participate in the consensus process. This function has long been performed with considerable skill and great dedication. With increasingly diverse agency interest in standards, however, more focused procedures will be required of each agency in dealing with standards bodies so that the Federal and company presence in the voluntary standards groups is effective.

2. Specification Writing

Over the past decade, Federal specifications and regulations have grown in scale so that they now represent a second major type of standard. Federal specifications are now frequently written by contract to the private sector. Voluntary standards are increasingly used, however, as the basis for such Federal specifications. This evolution changes the procedures, but does not remove the necessity, for continued Federal specification writing.

3. Standards Information

At four critical points in the entire standards development process, two important questions arise: (1) Has a standard already been developed? and (2) Is a standard now being developed by someone else? Definitive, economical answers to these questions will depend upon a standards information system that will identify standards activity already initiated by other institutions. Such a system can be shared by various agencies and by the private sector.

4. *Interinstitutional Collaboration*

The actual development of many technology standards, especially suitable environmental, safety, and health standards, is a responsibility shared with various Federal agencies and consensus bodies. When possible, therefore, the establishment of a generally agreed course of action is highly desirable. At five specific steps, such coordination is particularly important: (a) the establishment of priorities at three points and (b) modification of existing Federal regulations and specifications at two points.

B. Institutional (Federal Agency or Private Company) Functions

1. *Standards Management*

Any institution, public or private, that has a major interest in specific national standards will have to establish an institutional system to assure that proper action is taken at the proper time. There are two chief management tasks to be performed: (1) to assure that the entire development of individual standards takes place as rapidly as possible and (2) to chair the boards described in the next chapter in such a manner that institutional policy is exercised as uniformly as possible.

The first function dealing with individual standards is carried out through the establishment of the specific organizations required for smooth system operation. Ultimately, the chief function will consist of monitoring the progress of each standard as it is being selected and developed.

The second management function, chairing of the necessary boards, will be critical to the assurance of results satisfactory to the institution. This function must be performed with finesse, continuity, and uniformity, so that proper emphasis is given to each step.

2. *Priority Establishment*

In the systematic control of technology, in which environmental, safety, and health factors play an increasingly prominent part, the development of standards is one of two options. The other is administrative action. The choice between these two options is a question of priority establishment. The background for this choice is illustrated in figure 5. In this figure, the impact of hazards is plotted against the number of hazards with a given impact. This plot represents the perception that there are relatively few hazards with an overwhelming impact and, at the same time, a large number of relative trivia. As the product of a generic approach geared to widespread application, standards are suited to the control of those hazards with the greatest impact, those for which a mistake in individual judgment is most critical. Lesser hazards can be left to local decision, with minimum fear that errors in judgment or information will have serious consequences. The region in which the development of standards is most appropriate is represented in figure 5 by cross-hatching. The location of the boundary between this area and the rest is determined by the priority policy decision under discussion.

Such an illustration is unnecessarily simplistic, however. In practice, standards are generally developed according to a weighting, a priority, scheme equivalent to that shown in figure 6. The weighting function here, rather than being the step function shown in figure 5, is a curve that is effectively zero for the least important hazards and increases monotonically as the impact of the hazards increases. The realms of hazards and of the potential standards that might limit exposure to these hazards are then the product of such a weighting and the hazards curve depicted in figure 5. This product is a bell shaped curve such as that also shown in figure 6. A conservative system assumes that resources will not be adequate to support the simultaneous development of all standards represented by this curve. A detailed scheme is thus required to identify the most urgently needed standards, those with greatest impact. This priority selection, similar to that for identification of the most serious hazards, is also a question of policy.

3. *Technical Decision*

In addition to the purely technical, noncontroversial evaluation and review that are part of the standards development process to be addressed below, certain basically technical decisions will be difficult to make and will be controversial because they have to be based on conflicting or incomplete evidence. Examples of such decisions are the evaluation of existing limit standards, the decision whether to move ahead to the development of a given standard after key technical results have been subjected to field verification, and the decision whether to encourage development of a voluntary standard, a Federal specification, or both, etc. The controversy surrounding these technical decisions will be minimized by the inclusion of a spectrum of expertise within the agency, that is, within the Federal department or private company. At a minimum, all of those responsible for the development of the technology in question and those responsible for other relevant factors within the agency such as the environment, safety, and health should be a part of this decision process if later questioning is to be minimized.

4. *Technical Support for Limit Standards*

The preceding technical milestones and critical support activities included the necessity for a variety of specific technical services to support the development of limit standards. Professional judgment is required here both to establish background research programs and to answer very specific technical (e.g., environmental, safety, and health) questions. One example is the evaluation of the feasibility of bypassing specific steps in the standards development process. It is not essential that all such expertise be located in a single institution. It is important, however, that all such work be managed by technically trained staff able to provide their own evaluation.

5. *Technical Support for Compliance Measurement Standards*

Just as the support of biological and structural engineering staff is essential to the establishment of reliable limit standards, the establishment of reliable compliance measurement standards depends on two general types of technical support. The first is professional physical measurement expertise. The second is the development of statistical procedures geared to regulatory compliance. As the statistics suitable to research and development differ from the statistics designed for quality assurance, the statistics of regulatory control differ from each. The former two types of statistics, those for research and for quality assurance, exist in a relatively highly developed and extensively proven form. However, the statistics required for sophisticated regulatory control remain to be developed. Until such a methodology is developed, compliance measurements are nearly certain to be either inadequate or unnecessarily redundant.

Both of these types of support will require knowledge of the process being measured. Without this knowledge, for example, the variability cannot be estimated and the validity of the result cannot be estimated with assurance.

6. *System Tracking*

Several specific factors indicate that institutional management information systems will be required. The first factor is the complexity of any standards development. The second is the need for an institutional memory that will record and preserve the results of preceding priority decisions. Such records will be important because the priority of a given hazard will not in general be a simple function of its importance to one technology. The same hazard may surface several times, a process which cumulatively will raise the priority to the point that standards development should be undertaken. In the area of compliance as well, records will be required for later verification of the satisfactory performance of (e.g., energy technology development) systems.

VI. Basic Organizations Required for Comprehensive Standards Development

Each of the above 10 functions is clearly distinct from the others. Each contributes to the development of a standard at particular points in the development process. Each function is performed in response to a specific requirement. Each requires distinctive professional or technical resources. Each benefits from focused attention at specific levels of responsibility in Federal agencies and in private corporations.

Another factor is important to the definition of institutional standards processes. Where a given institutional function is performed in different major parts of the ES&H control process, in the consideration of hazards, in standards development, or in the generation of evidence of compliance (fig. 1), the execution of the function in each of these is quite distinct. That is, the clientele in each is different from that in the others. Each requires different professional or technical resources, and each is most appropriately performed in different parts of the agency or corporation.

These two basic considerations, the clear distinctions among different functions and the distinctions for a given function in different parts of the ES&H system, dictate the recognition of a set of distinct organizations. New organizations are therefore required in order to enable existing voluntary standards organizations and specification writing groups, the backbone of the present and future processes, to respond to rapidly increasing needs for ES&H standards. Through this institutional support, the voluntary standards groups can respond to the new pressures for ES&H standards with the same effectiveness that they have displayed in the past in the generation of commercial standards. Supported in this manner, the voluntary standards groups need not be changed substantially to play an increased role. A survey of all essential organizations follows.

A. National Organizations

1. Consensus Generation: Voluntary Standards Bodies

The number of individuals and institutions necessarily involved in the consensus process dictates a normally complex and therefore lengthy activity for the development of a particular standard. The voluntary standards bodies of the United States are performing this complex task with relative efficiency and expertise. Where criticism has been directed toward them, it is frequently, if not always, attributable to the failure of the appropriate Federal agencies and companies to provide the necessary technical support and coordination of their own responsibilities. The organizations described below are designed to provide this coordination and support for voluntary standards bodies in their present form. With such support, the existing standards groups can meet the greatly expanded needs for standards with present or even increased efficiency.

2. Specification Writers

Specifications are now written largely by a variety of groups in the private sector. There is no evidence requiring change in this system. Current trends to incorporate as often as possible suitable voluntary standards as the first stage in the development of Federal regulations will undoubtedly continue.

3. Standards Information System

A Standards Information System is essential for the performance of three functions. First, is a listing for any required subject area of information on all relevant existing voluntary standards, and governmental regulations and specifications. Second, is a similar listing of information on voluntary and governmental regulations and specifications that are being developed currently. And finally, is the provision of actual copy of existing standards to support the execution of other steps in the standards development process. To assure maximum utility, this system should be developed in close cooperation with the Boards that identify and select hazards and standards (listed below), so information on standards can be retrieved in the most convenient and economical way.

4. *Interinstitutional Collaboration: Hazards Review Board*

Effective interaction among agencies, both Federal and private, must occur at five specific points in standards development. The primary necessity in such interaction will be for review and support of the priorities established for hazards and the resulting standards selected for development. Such decisions will clearly have far-reaching implications throughout the public and private sectors. In particular, effective coordination at this point would address directly the widespread desire for increased anticipation and coordination of environmental and energy activity among institutions. The systematic review performed by the interinstitutional Hazards Review Board would follow informal interaction among the most directly involved institutions. A new emphasis on both formal and informal priority review would cement ties among both public and private agencies.

Interagency interaction on an *ad hoc* basis is also desirable where a Federal agency concludes after consideration of new evidence that a new regulation or specification similar but not identical to that developed by another agency is desirable. Collaboration between agencies is then clearly desirable.

The Hazards Review Board should clearly be chaired by a policy level agency manager in the field of ES&H. If the chairperson is not the Director of the DOE Office of Standards, then the Office would be involved indirectly through the provision of primary DOE support.

B. Institutional (Federal Agency or Private Company) Organizations

1. *Standards Management: Office of Standards*

The Office of Standards would take responsibility for the extensive start-up activity required. This would require, first, extensive consultation with all affected parts of the agency or company. Then the Office would need to establish essential organizations that do not yet exist, primarily those internal to the agency or company as discussed below.

On a continuing basis, the Office would manage the agency-wide or company-wide standards development process. The Office would also coordinate the existing activities involving other institutions. Two examples are the development of voluntary standards and of Federal specifications. Especially in the development of voluntary standards, the technical divisions and staff would contribute to development of an *ad hoc* agency strategy for each standard. This strategy would be jointly established under the aegis of the Office of Standards. Finally, as noted earlier, the critical Boards must be chaired in such a manner as to provide consistent and uniform policy execution. This continuity would be provided by the Office.

The effective execution of these functions will require an experienced staff, familiar with the various policy and technical issues involved and able to exercise judgment in dealing with complex situations.

2. *Priority Establishment*

(a) Hazards Action Board

The importance of institutional policies for the selection of hazards for analysis and of standards for development was stressed in the preceding chapter. The desirability of separating the hazards selection process from the selection of potential standards has also been noted. The Hazards Action Board would select those hazards that should receive top priority for consideration by the agency or company. The Board would also secure informal review of its priorities from other agencies. Since both the selection of hazards to be analyzed and the interaction with other agencies have wide implications, the Board should consist of broad policymakers in the Department.

(b) Standards Action Board

The selection of potential standards to be developed, although less far reaching than the choice of hazards to be addressed, is nevertheless crucial to the successful operation of a comprehensive standards development process. Without suitable selectivity, the national standards system would almost immediately become overloaded and cease to function effectively. The question arises, "Why is selectivity more crucial here than in the operation of existing standards development processes?" The difference arises from the removal of a diffused economic constraint. The development of commercial standards is ultimately controlled by the resources that industry, public interest groups, and governments are prepared to commit. This control is exercised throughout the entire standards process. A Federal agency or major corporation system, however, is free of this constraint and must control initial access to the process if it is not to become overloaded.

The Standards Action Board would operate effectively with membership consisting of deputies of the Hazards Action Board participants (at the Division Director or key staff level). It could appropriately be chaired by the Deputy Director for Policy of an Office of Standards.

3. *Technical Decision*

(a) Standards Review Board

Broadly based technical decisions that may be controversial would be the responsibility of a Standards Review Board. Controversy can arise either through incomplete data or from the existence of conflicting data. This Board would if necessary analyze issues in some detail from various professional points of view. Service on this Board, would therefore be intensive and of correspondingly short duration, perhaps a month. Continuity would be provided by a permanent chairperson from an Office of Standards, for example the Associate Director for Policy. The rotating positions would be filled by representatives of the technology divisions and relevant staff functions including environment and safety. Care would need to be exercised that technical breadth of expertise was represented on the Board at all times. Service on the Board, although a temporary drain on the time of the individuals involved, would nevertheless provide the Divisions with a valuable window on institutional uniformity in cases where this is a concern, e.g., for environmental, safety, and health questions. The Board would thus fill a role similar to that played by the Action Review Boards of the National Science Foundation. The similarity extends also to the necessity in each case to secure a broad, technically-based support for decisions that may have to withstand close scrutiny.

(b) Compliance Review Board

The ultimate demonstration of the efficacy of an environmental, safety, and health control system is the provision of data that show that installations are in compliance. Moreover these data, even when disappointing, provide vital clues for remedial action. They indicate, on the one hand whether the source of any difficulty is in the area of standards or administrative control. They also indicate which standards and control technology are open to question operationally. Because of the significance of both standards and control for the entire agency, it is important to have any evaluation of the degree of compliance as broadly based as possible. Representatives of the closely related technology divisions, and environmental divisions would be involved. Continuity could be provided by the choice of the Associate Director for Policy of an Office of Standards as Chairperson.

4. *Technical Support for Limits: Limit Standards Analysis Laboratory*

Technical support will be needed at various stages in the development of limit standards. In addition to specific technical support, two basic types of professional environmental, health, and safety expertise will be involved: biological evaluation for health-related issues and engineering analysis for safety-related issues. Even the coordination of the support activity will require sound technical judgment.

The likelihood that suitable technical coordination among the wide variety of specialties will indeed take place will be increased by location of the lead execution of this function in a technical laboratory that itself performs work in as many of these specialties as possible. The designation of a DOE national laboratory to play this role would be a relatively economical and expeditious way to provide the necessary services. It is not essential that activity in every required specialty be a part of the lead laboratory effort. However, the more of the activities that are represented, the more satisfactory will be the performance of the system and the less will be the likelihood of major errors in judgment.

Such a Laboratory would perform several types of work. First, it would provide general technical staff support for the development of limit standards. Such support would start with the development of limit standards weighting criteria to facilitate the establishment of priorities. The Laboratory would review potential hazards for the identification of potential limit standards. The Laboratory would then evaluate the calculated priorities in order to assure the reliable performance of the weighting system. One of the most important functions of the Laboratory would be to assure that a suitable research program is in place so that, as scientific and engineering analysis are needed in the future, the technology will be available. Finally, the Laboratory would provide critical technical advice on the selection and performance of contractors dealing with technical issues, including those involving environmental, safety, and health standards.

The second general type of work performed by this laboratory would be the actual research, development, and testing associated with the development of particular limit standards. Such activity would be planned and funded jointly by the relevant technology divisions and staff offices.

5. *Technical Support for Compliance*

(a) Physical Measurements: Compliance Measurement Standards Analysis Laboratory

This Laboratory would provide technical support for the development of compliance measurement standards in a manner analogous to the role of the Limit Standards Analysis Laboratory in the development of limit standards. Here too, there is a need for support of two types: support of an anticipated and continuing nature, and support for the evaluation and development of particular measurement technology. However, the expertise required differs from that required for limit standards. Compliance measurements standards require experts in physical measurements and engineering. Limit standards, on the other hand, as noted above, require biologists and engineers. The systematic structuring of physical measurements is required by the legal implications of the compliance process.

An initial task of compliance measurements technical support would be the development of compliance measurements standards weighting (priority) criteria that will facilitate the establishment of priorities and the ultimate selection (by the Standard Action Board) of those measurement standards to be developed. On a continuing basis, the Laboratory would review limit standards established by the preceding process for indications of need for compliance measurements standards. The priorities calculated with the data supplied would be reviewed for unexpected results and reevaluated if necessary.

In one way, however, this Laboratory would not function in a manner fully parallel to that of the Limit Standards Analysis Laboratory: the compliance Laboratory would review existing compliance measurements regulations and specifications when necessary. Such regulations and specifications developed at an earlier time cannot be accepted as suited to a new need without careful review. Since this review would be technical and usually not highly controversial, it need not be performed by the Standards Review Board except in exceptional circumstances. The development of suitable measurement technology would also be overseen by this Laboratory. Finally, this Laboratory would provide technical consultation and evaluation for the development of Federal specifications for compliance measurements standards.

Certain *ad hoc* support, such as the performance of directed background research and development, the development of specific technology, field verification of techniques, and field testing of voluntary standards would be negotiated with the particular technology divisions involved and with the technical staff.

(b) Statistics: Compliance Measurement Group

The statistical design of a set of measurements is a critical factor both in the validity of conclusions that can be drawn and the economy with which they can be made. As noted above, statistical design concepts for research and development differ basically from the corresponding design for quality control and assurance. In both research and quality control, the basis for the statistical designs is well understood. However, neither design is directly applicable to measurements for the demonstration of regulatory compliance. Statistical design for regulatory compliance differs from the other fields also in that a firm foundation for activity does not yet exist. Therefore, the first task of a compliance measurement group would be to assure the critically needed statistical methodology for regulatory compliance. In addition two other functions are required. The first is the review of compliance measurements standards as they are developed for "statistical compliance" with the best applicable statistical methodology. The second task would be to develop special statistical protocols where appropriate for specific standards for which the general principles developed were inapplicable.

Statistical services of a more routine sort to support the design and interpretation of experiments will be required by both technical support laboratories. The Compliance Measurement Group could provide the statistical support for one of these laboratories if the Group were located in it. In principle, the Compliance Measurements Standards Analysis Laboratory would provide a natural home for this service.

6. *System Tracking*

(a) Hazards Action Tracking System

Detailed tracking of the operation of the hazards identification and selection process is crucial for two reasons. First a continuous monitoring of the system will avoid very severe duplication of effort as multiple sources of hazards identification locate the same hazard. Moreover, a hazard identified by only one such technology will not necessarily present a high enough priority for action. In many cases, however, after several technologies have been identified, a hazard will eventually assume enough visibility to trigger the development of a standard. Therefore, a systematic means will be essential to record this "accrual" of significance so that realistic "aggregated" priorities can be established. It is clear that such a system will have to contain the data necessary for weighting as well as the technical information on hazards.

(b) Standards Action Tracking System

For reasons similar to the need for hazards tracking within the institution, there is an analogous need for the tracking of standards development. One system could well serve the development of both limit standards and compliance measurement standards. At a minimum, progress in the development of standards from major step to major step should be tracked. More detailed tracking would not be undertaken unless the need arose. The system should also provide for time monitoring so that delays can be noted and schedules reformulated.

(c) Agency (Company) Standards and Compliance Report Library

The permanent products of the entire system will be of two kinds. The immediate product will be standards, both voluntary and Federal specifications. A later and continuing product will be compliance reports from agency field installations and from energy-related industries. A common library could serve as a depository for both types of documents.

The provision of copies of Agency-sponsored standards could also become a service of this library. Alternatively, the Standards Information System could be developed to perform this function and relieve thereby the agency of this responsibility.

The collection of compliance reports, however, would fulfill a special role. Each report would need to be evaluated and a decision made whether or not it represented satisfactory performance. At some point in the future, a survey reporting system may be required. Such a system would review compliance reports for a given period and characterize the performance represented.

VII. Detailed Description of System Operation Through an Example: NO_2

The system presented in figure 4, where it is coded by structural element, is presented again in figure 7, coded by the preceding management functions identified in the table. The operation of this detailed plan will now be described by following the development of hypothetical NO_2 standards.

A. Hazards Analysis

The process starts with the identification of a potential hazard by an agency contractor. In our hypothetical example, the contractor notes the anticipated emission of NO_2 by a coal gasification plant being designed. In complying with agency contracts, the contractor is obliged also to identify environmental, health, and safety effects and to estimate their impact. In this case NO_2 is identified by the contractor as having a potential impact on 5000 school children by association with cases of bronchitis. This prognosis enables the Hazards Analysis Tracking System to calculate a priority for attention to NO_2. This list is reviewed by the Hazards Action Board for completeness of the information and for the selection of certain hazards for immediate attention. NO_2 is placed on this list of selected hazards, which is referred to other agencies for informal comment. EPA staff agree informally that NO_2 is a potential hazard at the level specified. NO_2 then is placed on a draft list of hazards that e.g., DOE is addressing, to be published in the Federal Register by the Hazards Action Board. This draft list is sent to the (interagency) Hazards Review Board for formal consideration by other agencies. After questions raised by these agencies have been resolved, NO_2 is cited in a Federal Register "List of Potential Hazards Receiving Immediate Attention by (e.g., the U.S. Department of Energy)."

B. Development of Limit Standard

Each of the selected potential hazards is analyzed for the importance and costs of a standard that would limit exposure. NO_2 is thus analyzed by the Limit Standards Analysis Laboratory and placed in the Standards Action Tracking System, which calculates a priority for the development of an NO_2 emission limit standard according to a scheme developed by the Laboratory. The priorities thus calculated are reviewed by the Laboratory for unexpected ranking and transmitted to the (policy) Standards Action Board, which selects the potential limit standards action to be carried forward. NO_2 is placed on such a selected list transmitted informally to other agencies for comment. The other agencies agree that a suitable NO_2 emission limit standard is highly desirable, and the list is transmitted to the Hazards Review Board for formal consideration by the agencies cited in a Federal Register. After other agency comments have been addressed, NO_2 is cited in "List of Existing and Potential Standards Receiving Immediate Attention by (e.g., the U.S. Department of Energy)."

The first question to be asked of all selected potential standards is "Does one already exist?" The Standards Information System locates an existing standard. A copy of this standard is transmitted to the Standards Review Board for a broadly based technical review for suitability to the needs of the agency. If this review showed that the standard was suitable, then the development of the limit standard would be bypassed. However, the hypothetical review finds new evidence that casts into question the continued suitability of the existing standard. The process then resumes as if no standard existed (but in with full awareness of all evidence). The Standards Information System is then queried whether or not a voluntary standard exists. If one were found, the development of another would be bypassed. Through this and succeeding bypasses much of the complete procedure can be circumvented for many of the environmental, safety, and health questions that are raised initially. However, a voluntary NO_2 emission limit standard is not found in our hypothetical example. The action is then transferred to the Limit Standards Analysis Laboratory.

The Limit Standards Analysis Laboratory first examines the technical evidence to ascertain whether or not there is sufficient evidence to establish a defensible standard limiting the emission of NO_2. If there were sufficient evidence, then the generation of that evidence would be bypassed. However, we postulate that the evidence does not exist. The missing evidence is identified and research undertaken to obtain it. In this case, some basic biological testing techniques and an atmospheric flow model are needed and the research is planned and executed. The desirable limit is then established by some directed research, and the critical results are verified in another laboratory. The Standards Review Board looks at the key research results and the verification data and finds that they are sufficient to proceed with the development of a standard. If the results had been considered unsatisfactory, then the discrepancies would have had to be resolved in the laboratory.

At this point the detailed development of a particular NO_2 standard by existing bodies can begin. The first question to be resolved is whether a voluntary standard is to be developed, or a Federal emission specification, or both. There is no justification in this case to bypass the voluntary standard process, so a consensus standard is developed. To do so, the Office of Standards transmits the request to ANSI along with a designation of the amount of time available. ANSI recommends several committees that could handle it. The Office then identifies the agency or company representatives on these committees. Through consultation with the cognizant agency technical division, other agency representatives are nominated to participate in the activity. A strategy is developed by those involved. The strategy includes the nomination of the most appropriate voluntary standards committee to handle the development. The strategy is then executed. Once developed, the NO_2 emission limit standard is field tested by the Limit Standards Analysis Laboratory and the results evaluated by the Standards Review Board. With satisfactory results of the field test, the previous decision on whether a specification is to be developed is noted. In this case, a specification is considered necessary and it is developed on contract. The NO_2 emission limit specification (and voluntary standard) are assigned reference numbers, the Standards Information System is so informed, and the necessity for a compliance measurement standard is noted.

C. Development of a Compliance Measurement Standard

The development of an NO_2 compliance measurement standard is quite similar to the development of the NO_2 emission limit standard that made it necessary. The Compliance Standards Analysis Laboratory analyzes the NO_2 emission limit standard and then evaluates the priority assigned to it by the Standards Action Tracking System. A compliance measurement standard is identified as critical for field measurement and is selected for development by the Standards Action Board. This decision is informally reviewed favorably by other agencies. The need for an NO_2 compliance measurement standard is then identified in the list of selected standards transmitted for formal comment to the Hazards Action Board. After favorable review, a search is made through the Standards Information System for existing regulations. In this case one is located and found after technical activity by the Compliance Standards Analysis Laboratory to be open to serious question. Next, the Standards Information System is queried for the existence of voluntary NO_2 compliance measurement standards. None exist, so action is transferred to the Compliance Measurement Analysis Laboratory for technical analysis. The existing technology is questionable, so the discrepant methods are investigated. The methods are found to be as bad as suspected (a factor of 3 in error over parts of the range of interest). The development of NO_2 standard reference materials is now undertaken and their performance verified in another laboratory. The results are compared by the Standards Review Board and found to be in agreement.

Development of the formal NO_2 compliance measurement standard can now take place. The first step is to decide whether a voluntary standard or an agency specification, or both, is required. Both are found to be necessary, so the voluntary compliance measurement standard is developed in a manner analogous to the development of the voluntary NO_2 emission limit standards. The voluntary NO_2 compliance measurement standard is tested in the field by the Compliance Standard Analysis Laboratory. The results of this test as evaluated by the Standards Review Board are satisfactory, and the decision to develop a Federal specification is noted. This specification is developed by a contractor and the statistical protocols are found to be satisfactory. A compliance reporting procedure is developed, the standard receives a number for future reference and the Standards Information System is notified.

D. Evidence of Compliance

Reports filed by emitters of NO_2 are received in the Standards and Compliance Reports Library and transmitted to the Compliance Review Board. If judged by the Board to demonstrate satisfactory NO_2 control, the reports are stamped accordingly and constitute a permanent record in the library. If, on the other hand, the control of NO_2 is considered to be outside of the limits established, then two actions are undertaken. First, the compliance measurement standard is returned to the Standards Action Board for reevaluation of the standard and possible reconsideration. Simultaneously, an investigation of the control technology must be undertaken.

VIII. A Final Word on Simplicity

The designation of many specific standards development stages and several organizations will strike the reader unfamiliar with standards as frivolous at best or inordinately ambitious and expensive at worst. However, the detailed stages described actually represent a simplification of typical *existing* procedures, a simplification made possible by the designation of specific company or agency organizations to supplement and assist existing consensus organizations. If the initial goal, a system assuring the expeditious and economical development of all necessary standards, is to be met, then the scheme described is in fact the simplest general one. That is, the number of general elements is indeed an absolute minimum. In many specific cases, however, some stages can be bypassed with relatively little likelihood of difficulty. But, any further general combination of the designated functions will lead either to work performed by inappropriate staff or confusion as to responsibility. The result would be either delayed standards development or inappropriate standards.

In fact, because of the general effectiveness of existing voluntary standards bodies, the new systems required are each individually rather simple and modest. Moreover, the coordination of performance of each through a small appropriate staff in an agency or company Office of Standards should be sufficient to assure the continued smooth operation of the entire national system. No simpler structure will fulfill the long-term needs. Clearly, however, such a system can be effectively established only through consultation with all affected and over an extensive period of time.

IX. References

[1] Bruce Steiner, The timely development of environmental, safety, and health standards for energy technologies (submitted for publication).

[2] Samuel Etris, private communication.

[3] James Gruhl, Review of methods for assessing the carcinogenic hazards from coal-using energy technologies. MITEL 76015 (NTIS PB270 682) 1976.

X. List of Figures

STANDARDS DEVELOPMENT FUNCTIONS

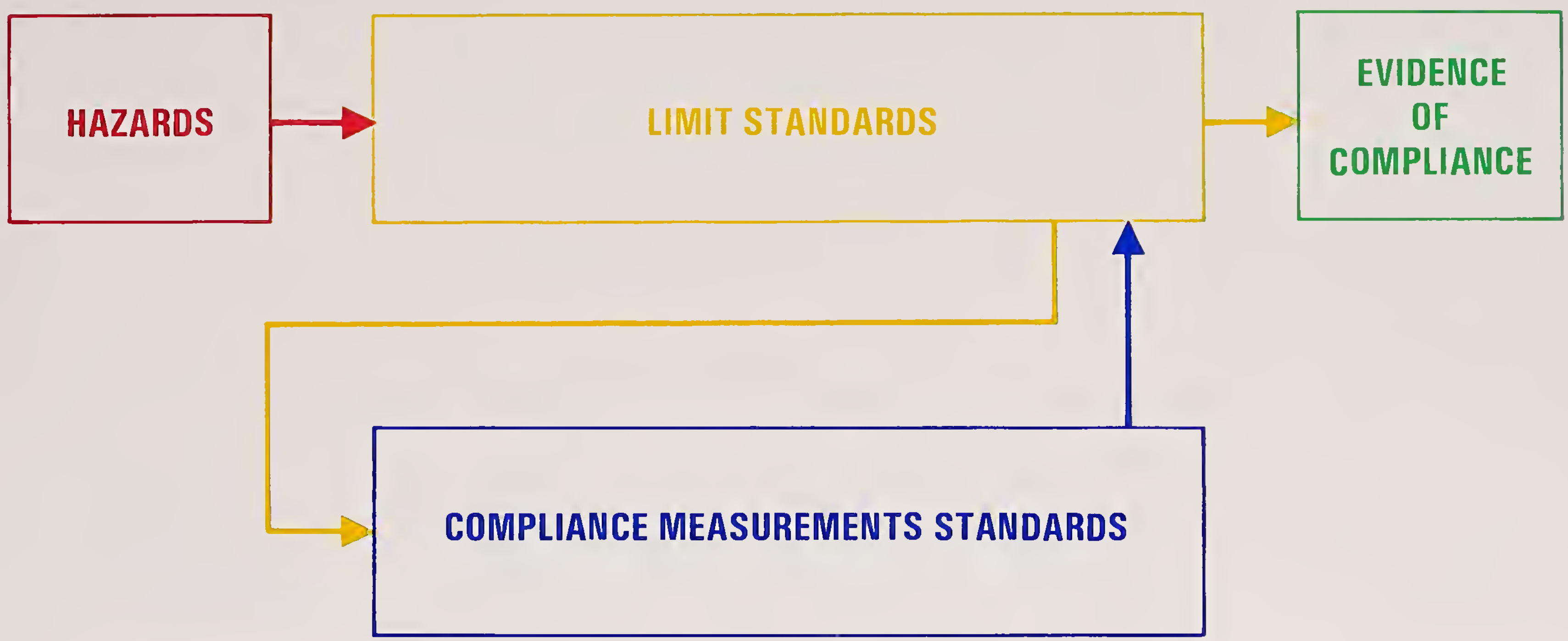
NATIONAL

1. CONSENSUS GENERATION*
2. SPECIFICATION WRITING*
3. STANDARDS INFORMATION
4. INTERINSTITUTIONAL COLLABORATION

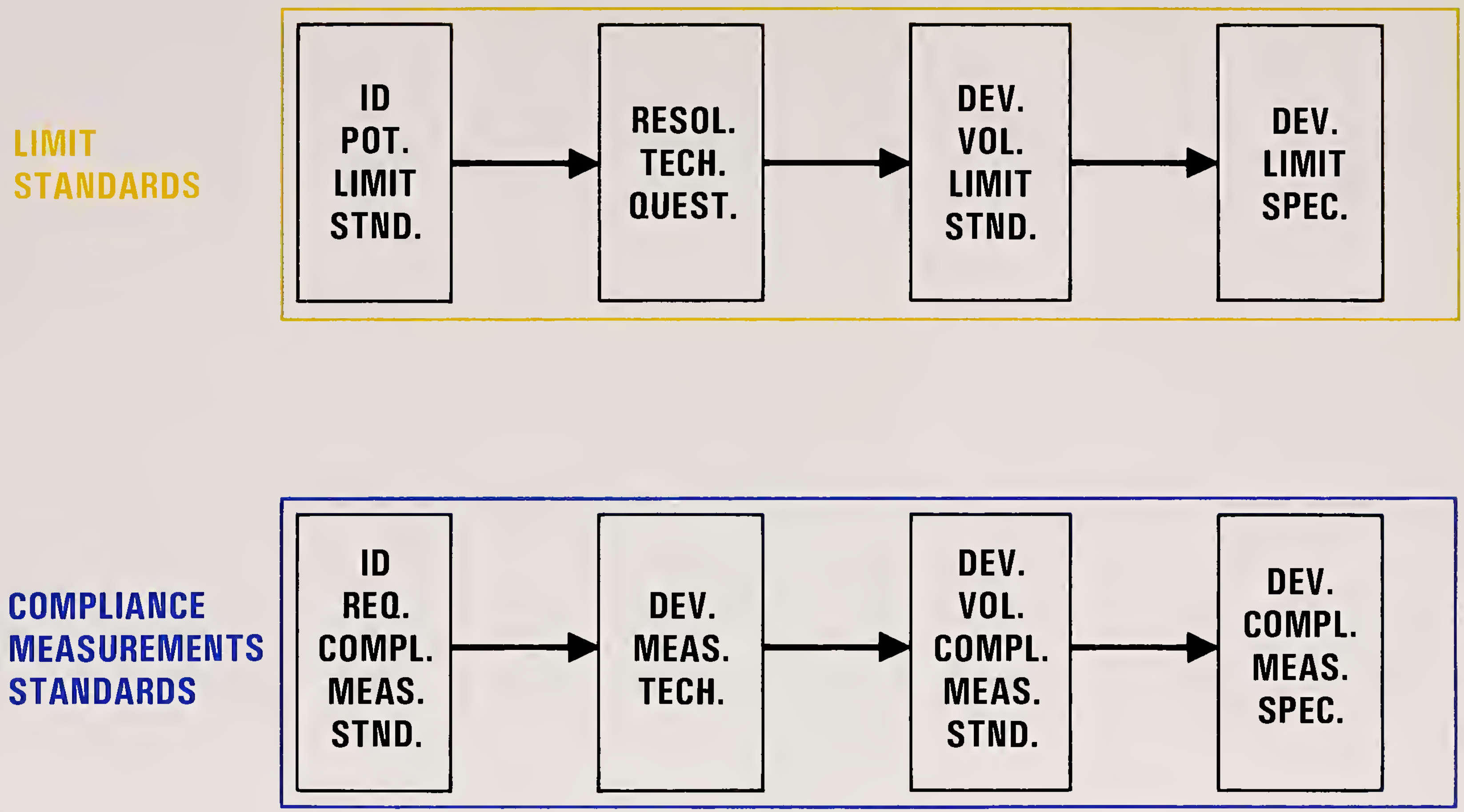
INSTITUTIONAL

1. STANDARDS MANAGEMENT
2. PRIORITY ESTABLISHMENT
3. TECHNICAL DECISION
4. TECHNICAL SUPPORT FOR LIMIT STANDARDS
5. TECHNICAL SUPPORT FOR COMPLIANCE MEASUREMENT STANDARDS
6. SYSTEM TRACKING

*Existing functions: interface with institutions via institutional standards management

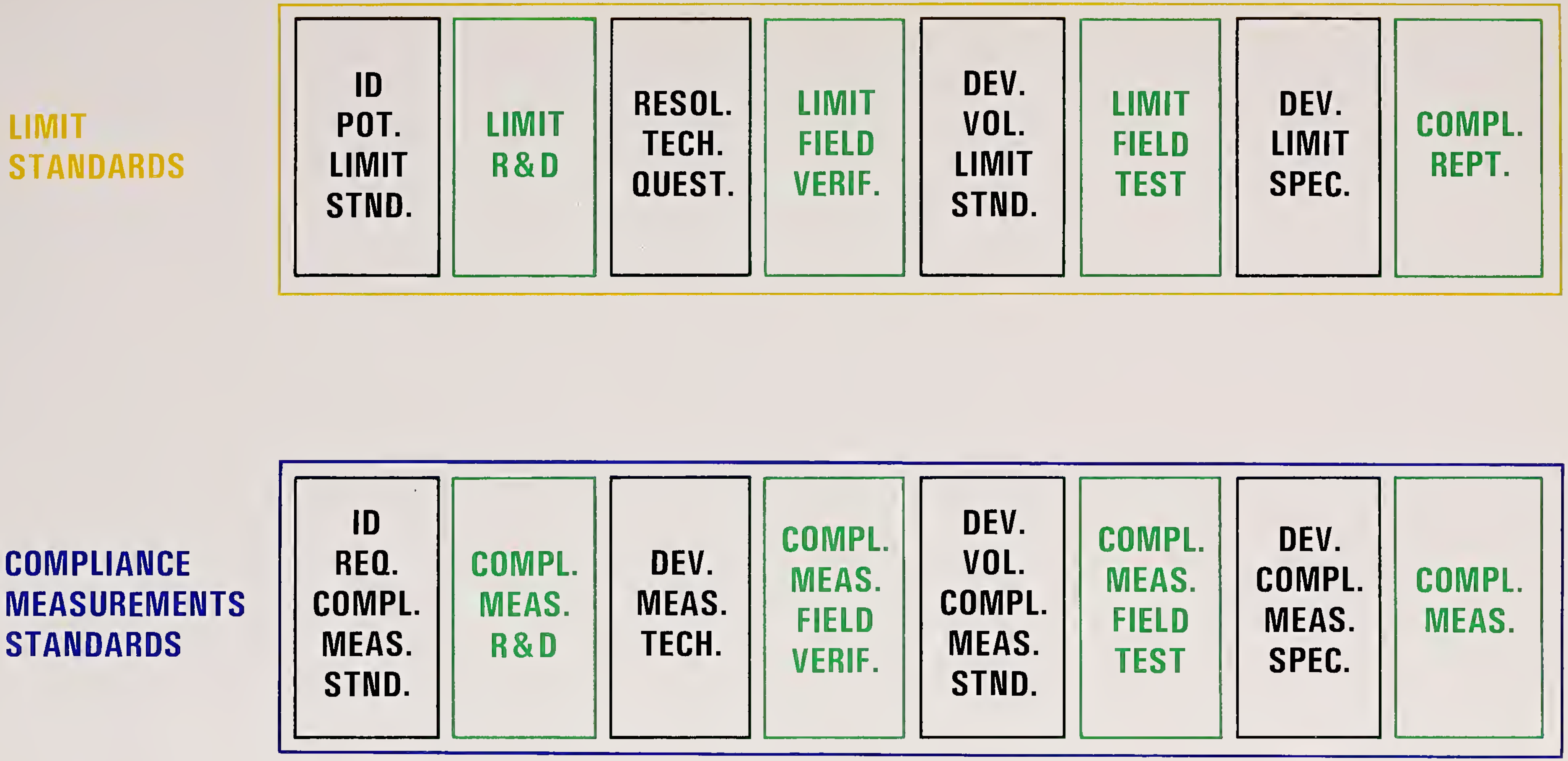


GREATER ES & H STANDARDS SYSTEM
Figure 1



MAJOR STANDARDS MILESTONES

Figure 2



CRITICAL STANDARDS SUPPORT ACTIVITIES

Figure 3

ENERGY RELATED (NON-NUCLEAR) ENVIRONMENTAL SAFETY & HEALTH STANDARDS DEVELOPMENT SYSTEM FOR DOE (STRUCTURE)

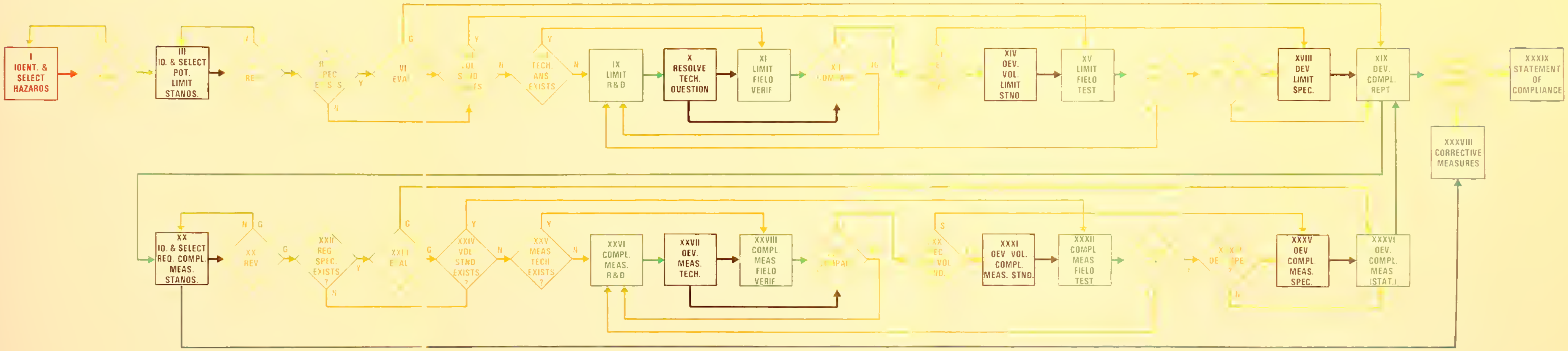


Figure 4

ATED (NON-NUCLEAR) ENVIRONMENTAL SAFETY & HEALTH STANDARDS DEV

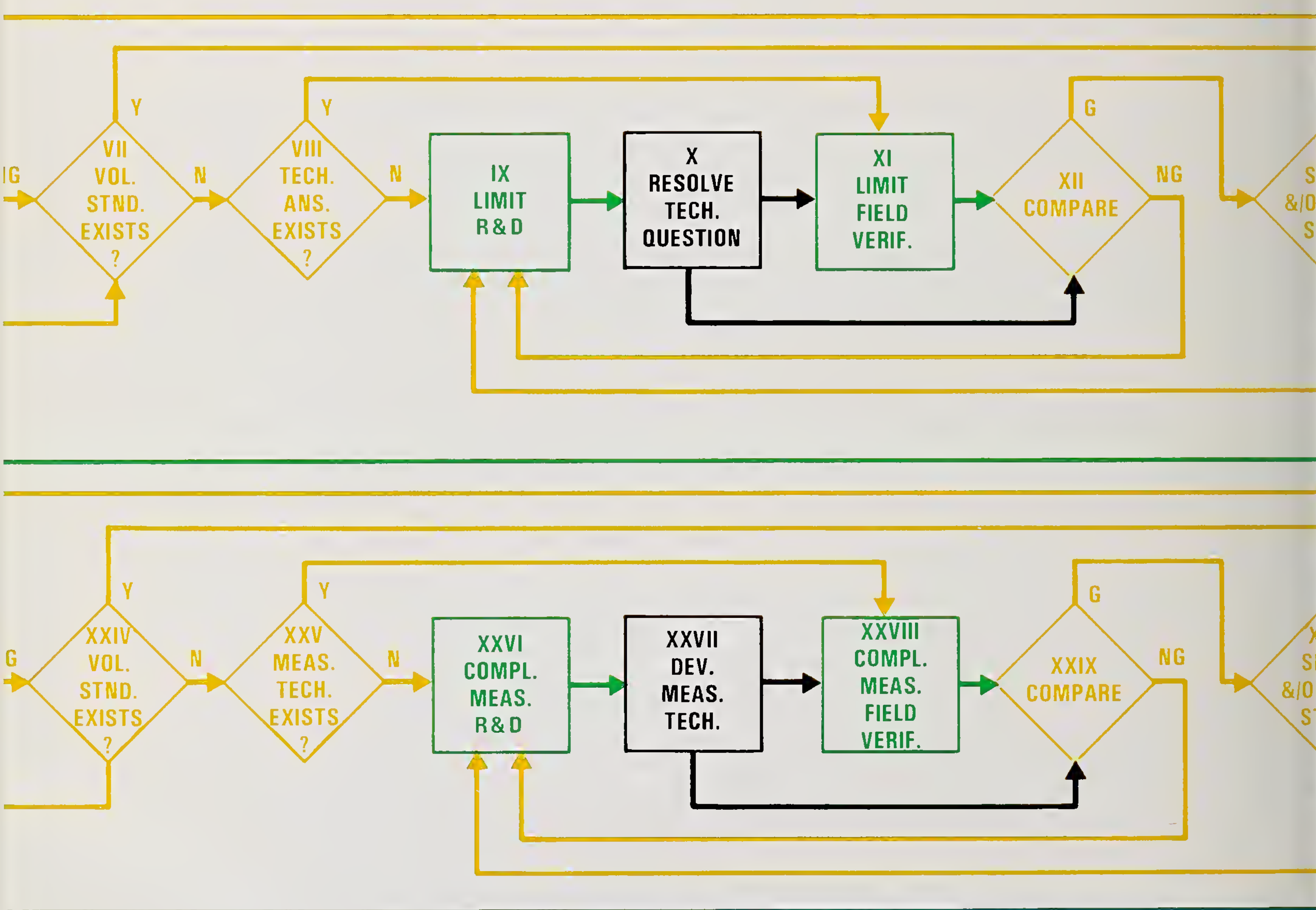
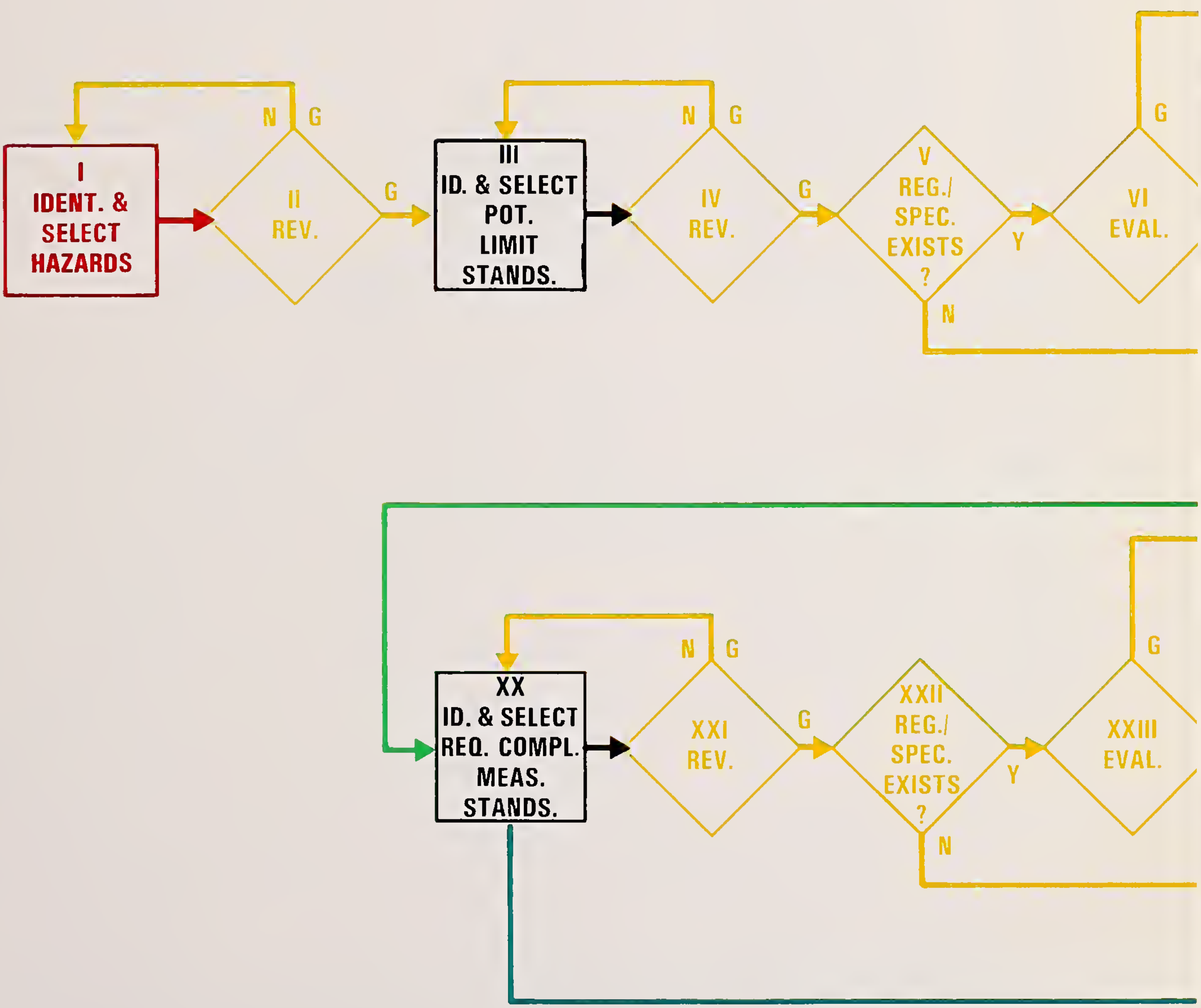
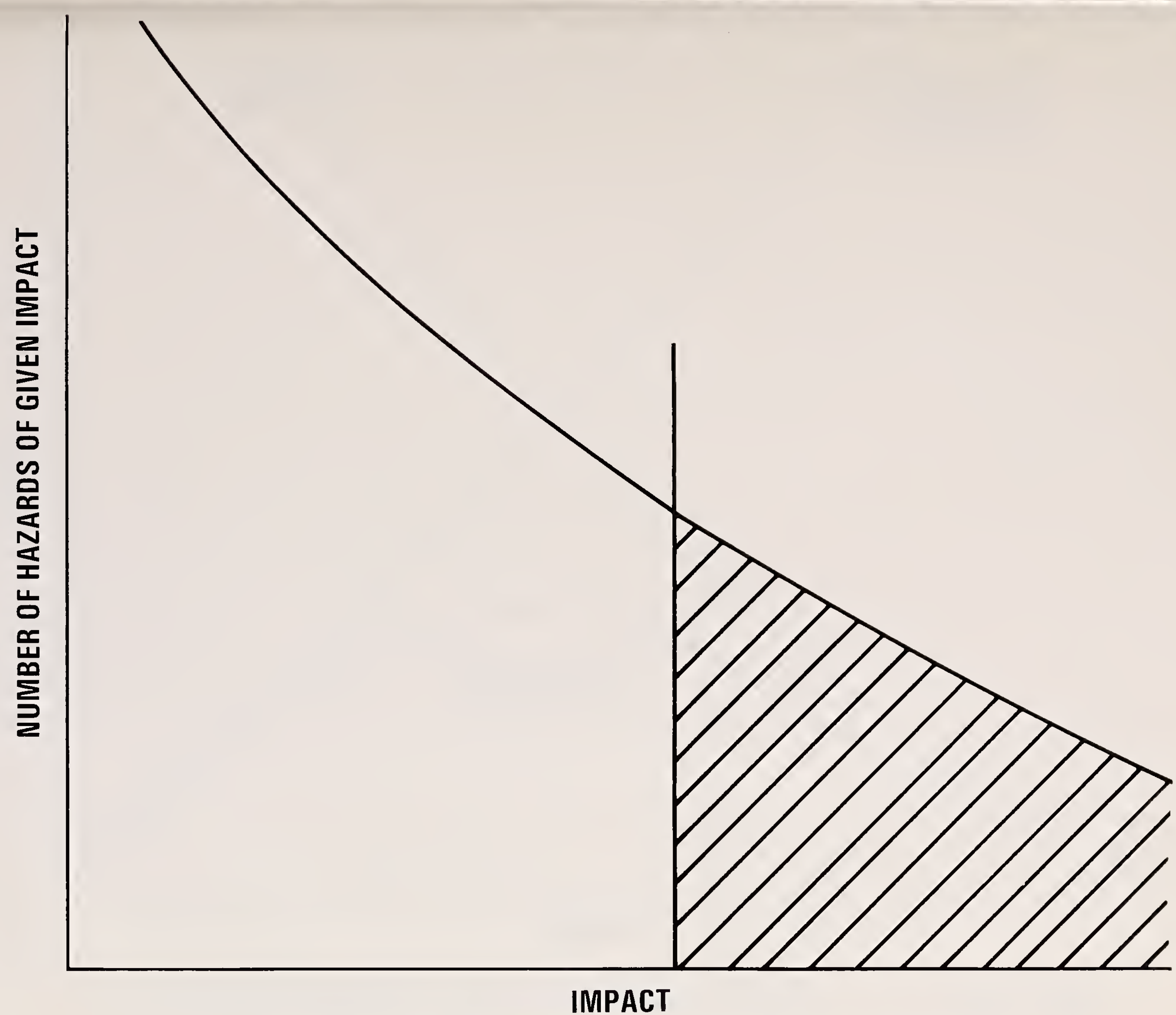


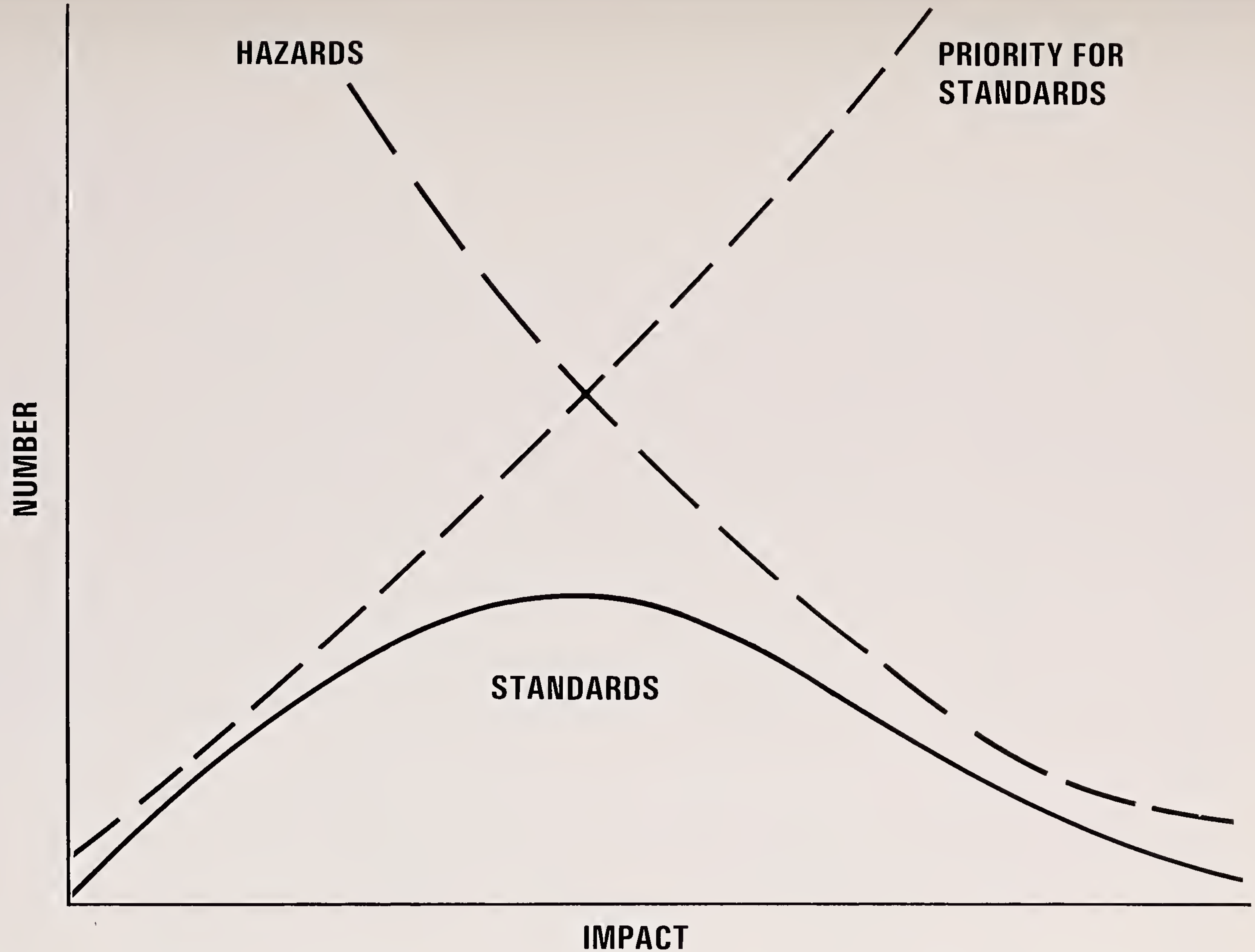
Figure 4

ENERGY RE


I
IDENT. &
SELECT
HAZARDS
N
G
II
REV.
G
III
ID. & SELECT
POT.
LIMIT
STANDS.
N
G
IV
REV.
G
V
REG./
SPEC.
EXISTS
?
Y
N
G
VI
EVAL.
XX
ID. & SELECT
REQ. COMPL.
MEAS.
STANDS.
N
G
XXI
REV.
G
XXII
REG./
SPEC.
EXISTS
?
Y
N
G
XXIII
EVAL.



CHARACTERIZATION OF HAZARDS
Figure 5



CHARACTERIZATION OF POTENTIAL STANDARD

Figure 6

ED (NON-NUCLEAR) ENVIRONMENTAL SAFETY & HEALTH STANDARDS DEVELOPMENT SYSTEM FOR DOE (FUNCTION)

ATI

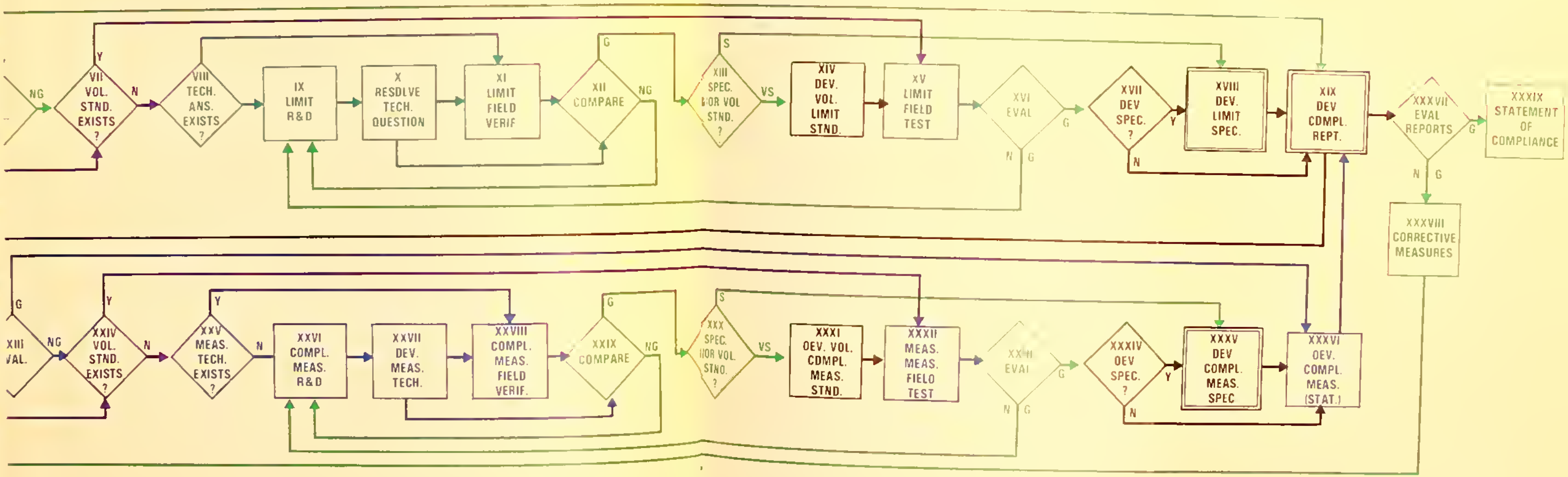


Figure 7

ED (NON-NUCLEAR) ENVIRONMENTAL SAFETY & HEALTH STANDARDS DEVE

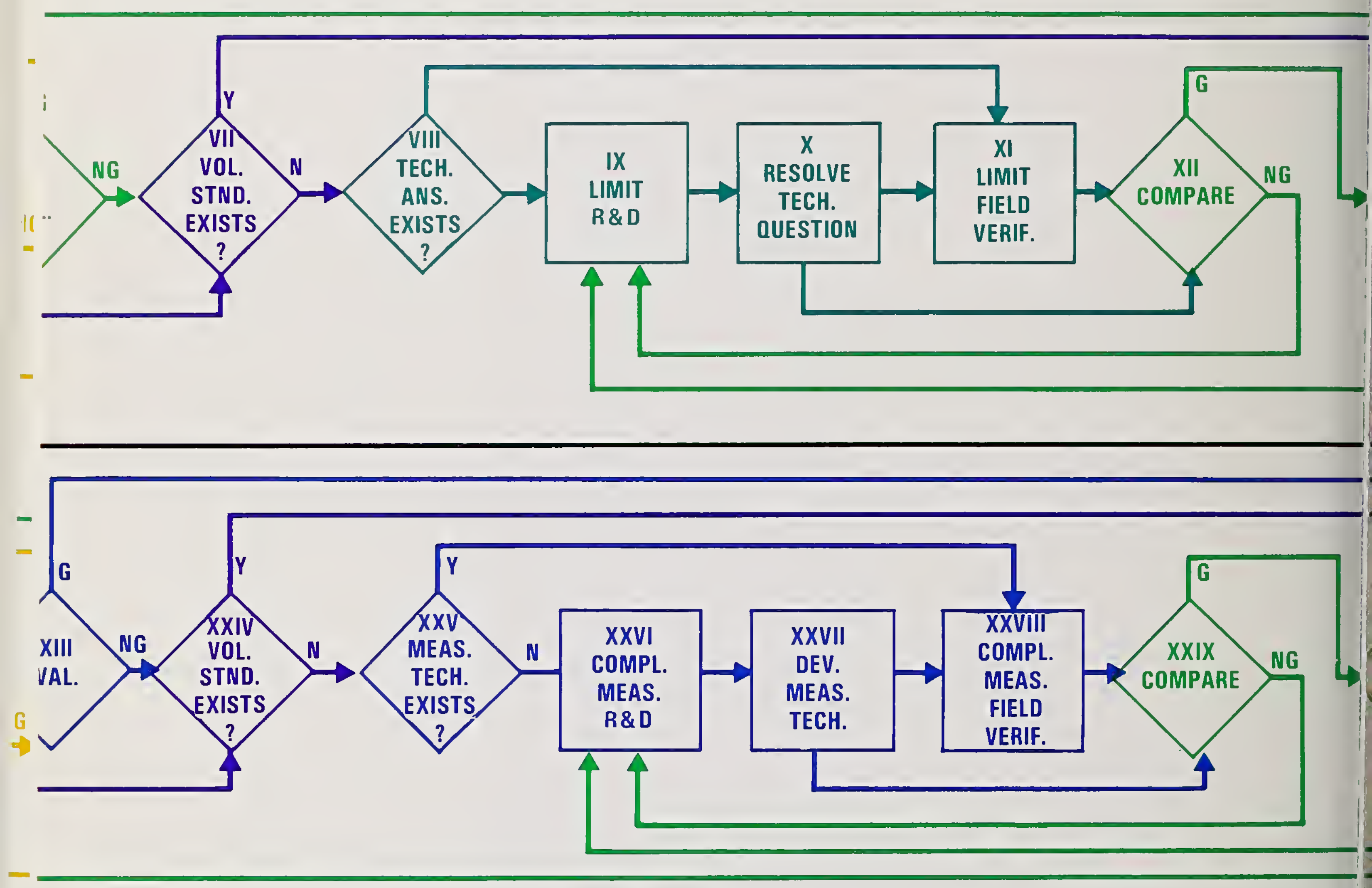
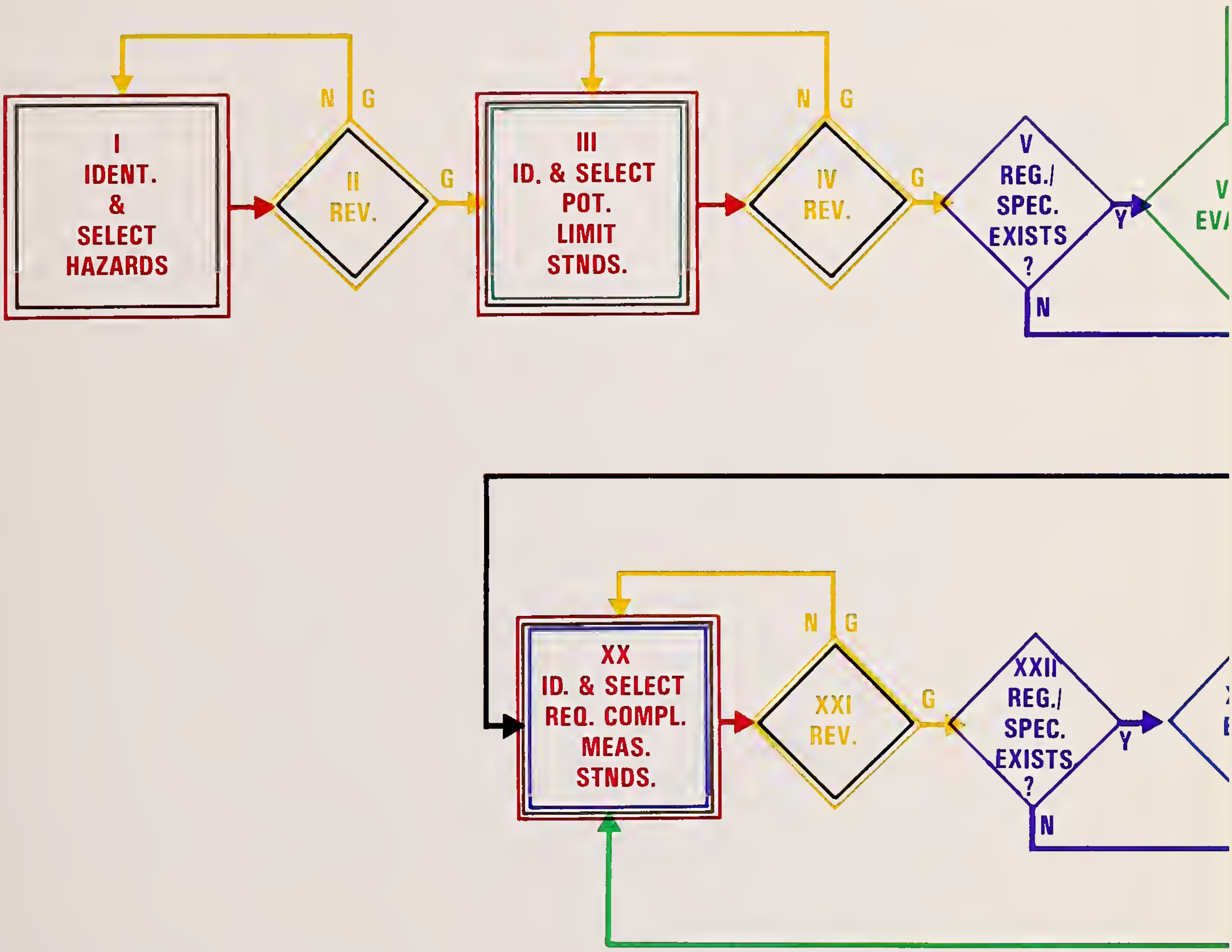


Figure 7

ENERGY RELA


I
IDENT.
&
SELECT
HAZARDS
N
G
II
REV.
G
III
ID. & SELECT
POT.
LIMIT
STNDS.
N
G
IV
REV.
G
V
REG./
SPEC.
EXISTS
?
Y
N
XX
ID. & SELECT
REQ. COMPL.
MEAS.
STNDS.
N
G
XXI
REV.
G
XXII
REG./
SPEC.
EXISTS
?
Y
N

NBS-114A (REV. 9-78)

U.S. DEPT. OF COMM. BIBLIOGRAPHIC DATA SHEET	1. PUBLICATION OR REPORT NO. NBS MN 165	2. Gov't. Accession No.	3. Recipient's Accession No.

4. TITLE AND SUBTITLE	5. Publication Date
AN INSTITUTIONAL PLAN FOR DEVELOPING NATIONAL STANDARDS With special reference to Environment, Safety, & Health	Sept. 1979
	6. Performing Organization Code
7. AUTHOR(S) Bruce W. Steiner	8. Performing Organ. Report No.
9. PERFORMING ORGANIZATION NAME AND ADDRESS NATIONAL BUREAU OF STANDARDS DEPARTMENT OF COMMERCE WASHINGTON, DC 20234	10. Project/Task/Work Unit No.
	11. Contract/Grant No.
12. SPONSORING ORGANIZATION NAME AND COMPLETE ADDRESS *(Street, City, State, ZIP)* Same as item 9	13. Type of Report & Period Covered NA
	14. Sponsoring Agency Code

15. SUPPLEMENTARY NOTES

Library of Congress Catalog Card Number: 79-600116

☐ Document describes a computer program; SF-185, FIPS Software Summary, is attached.

16. ABSTRACT *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)*

This plan was commissioned to provide a framework for the development of all essential non-nuclear energy-related, environmental, safety, and health (ES&H) standards for the private sector to coincide with the commercialization of new energy technologies. The development of such standards in the United States is a subset of the development of technological standards. Such standards consist of two basic types: "limit standards," which establish system performance criteria and "compliance measurement standards," which establish methods for the demonstration of compliance with "limit standards." The system addressed in this report encompasses four basic elements: (1) Hazards, (2) Limit Standards, (3) Evidence of Compliance, and (4) Compliance Measurement Standards. The unabridged version of the standards development process contains 39 discrete steps, each of which consists of intermediate stages. These are described here in the context of ten essential standards management functions. Some essential components in a comprehensive system, such as the voluntary standards bodies, already exist. However, to carry out many of the other functions effectively, new organizations would be required. The operation of the entire process is described in terms of a hypothetical example.

17. KEY WORDS *(six to twelve entries; alphabetical order; capitalize only the first letter of the first key word unless a proper name; separated by semicolons)*

Energy standards; environmental standards; safety and health standards; standards development

18. AVAILABILITY ☒ Unlimited	19. SECURITY CLASS (THIS REPORT) UNCLASSIFIED	21. NO. OF PRINTED PAGES 24
☐ For Official Distribution. Do Not Release to NTIS ☒ Order From Sup. of Doc., U.S. Government Printing Office, Washington, DC 20402, SD Stock No. 003-003-02094-0 ☐ Order From National Technical Information Service (NTIS), Springfield, VA. 22161	20. SECURITY CLASS (THIS PAGE) UNCLASSIFIED	22. Price

☆ U.S. GOVERNMENT PRINTING OFFICE : 1979 O—297-942

NBS TECHNICAL PUBLICATIONS

PERIODICALS

JOURNAL OF RESEARCH—The Journal of Research of the National Bureau of Standards reports NBS research and development in those disciplines of the physical and engineering sciences in which the Bureau is active. These include physics, chemistry, engineering, mathematics, and computer sciences. Papers cover a broad range of subjects, with major emphasis on measurement methodology and the basic technology underlying standardization. Also included from time to time are survey articles on topics closely related to the Bureau's technical and scientific programs. As a special service to subscribers each issue contains complete citations to all recent Bureau publications in both NBS and non-NBS media. Issued six times a year. Annual subscription: domestic $17; foreign $21.25. Single copy, $3 domestic; $3.75 foreign.

NOTE: The Journal was formerly published in two sections: Section A "Physics and Chemistry" and Section B "Mathematical Sciences."

DIMENSIONS/NBS—This monthly magazine is published to inform scientists, engineers, business and industry leaders, teachers, students, and consumers of the latest advances in science and technology, with primary emphasis on work at NBS. The magazine highlights and reviews such issues as energy research, fire protection, building technology, metric conversion, pollution abatement, health and safety, and consumer product performance. In addition, it reports the results of Bureau programs in measurement standards and techniques, properties of matter and materials, engineering standards and services, instrumentation, and automatic data processing. Annual subscription: domestic $11; foreign $13.75.

NONPERIODICALS

Monographs—Major contributions to the technical literature on various subjects related to the Bureau's scientific and technical activities.

Handbooks—Recommended codes of engineering and industrial practice (including safety codes) developed in cooperation with interested industries, professional organizations, and regulatory bodies.

Special Publications—Include proceedings of conferences sponsored by NBS, NBS annual reports, and other special publications appropriate to this grouping such as wall charts, pocket cards, and bibliographies.

Applied Mathematics Series—Mathematical tables, manuals, and studies of special interest to physicists, engineers, chemists, biologists, mathematicians, computer programmers, and others engaged in scientific and technical work.

National Standard Reference Data Series—Provides quantitative data on the physical and chemical properties of materials, compiled from the world's literature and critically evaluated. Developed under a worldwide program coordinated by NBS under the authority of the National Standard Data Act (Public Law 90-396).

NOTE: The principal publication outlet for the foregoing data is the Journal of Physical and Chemical Reference Data (JPCRD) published quarterly for NBS by the American Chemical Society (ACS) and the American Institute of Physics (AIP). Subscriptions, reprints, and supplements available from ACS, 1155 Sixteenth St., NW, Washington, DC 20056.

Building Science Series—Disseminates technical information developed at the Bureau on building materials, components, systems, and whole structures. The series presents research results, test methods, and performance criteria related to the structural and environmental functions and the durability and safety characteristics of building elements and systems.

Technical Notes—Studies or reports which are complete in themselves but restrictive in their treatment of a subject. Analogous to monographs but not so comprehensive in scope or definitive in treatment of the subject area. Often serve as a vehicle for final reports of work performed at NBS under the sponsorship of other government agencies.

Voluntary Product Standards—Developed under procedures published by the Department of Commerce in Part 10, Title 15, of the Code of Federal Regulations. The standards establish nationally recognized requirements for products, and provide all concerned interests with a basis for common understanding of the characteristics of the products. NBS administers this program as a supplement to the activities of the private sector standardizing organizations.

Consumer Information Series—Practical information, based on NBS research and experience, covering areas of interest to the consumer. Easily understandable language and illustrations provide useful background knowledge for shopping in today's technological marketplace.

Order the **above** *NBS publications from: Superintendent of Documents, Government Printing Office, Washington, DC 20402.*

Order the **following** *NBS publications—FIPS and NBSIR's—from the National Technical Information Services, Springfield, VA 22161.*

Federal Information Processing Standards Publications (FIPS PUB)—Publications in this series collectively constitute the Federal Information Processing Standards Register. The Register serves as the official source of information in the Federal Government regarding standards issued by NBS pursuant to the Federal Property and Administrative Services Act of 1949 as amended, Public Law 89-306 (79 Stat. 1127), and as implemented by Executive Order 11717 (38 FR 12315, dated May 11, 1973) and Part 6 of Title 15 CFR (Code of Federal Regulations).

NBS Interagency Reports (NBSIR)—A special series of interim or final reports on work performed by NBS for outside sponsors (both government and non-government). In general, initial distribution is handled by the sponsor; public distribution is by the National Technical Information Services, Springfield, VA 22161, in paper copy or microfiche form.

BIBLIOGRAPHIC SUBSCRIPTION SERVICES

The following current-awareness and literature-survey bibliographies are issued periodically by the Bureau:

Cryogenic Data Center Current Awareness Service. A literature survey issued biweekly. Annual subscription: domestic $25; foreign $30.

Liquefied Natural Gas. A literature survey issued quarterly. Annual subscription: $20.

Superconducting Devices and Materials. A literature survey issued quarterly. Annual subscription: $30. Please send subscription orders and remittances for the preceding bibliographic services to the National Bureau of Standards, Cryogenic Data Center (736) Boulder, CO 80303.

U.S. DEPARTMENT OF COMMERCE
National Bureau of Standards
Washington, D.C. 20234

OFFICIAL BUSINESS

Penalty for Private Use, $300

POSTAGE AND FEES PAID
U.S. DEPARTMENT OF COMMERCE
COM-215

U.S.MAIL

SPECIAL FOURTH-CLASS RATE
BOOK