DNFSB/TECH-16

INTEGRATED SAFETY MANAGEMENT

Defense Nuclear Facilities Safety Board

Technical Report

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INTEGRATED SAFETY MANAGEMENT

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Frontispiece

Since its inception in 1989, the Defense Nuclear Facilities Safety Board (Board) has issued a number of recommendations to the Secretaries of the Department of Energy (DOE) in the interest of improving DOE's program for ensuring the protection of public and worker safety and the environment in the design, construction, operation, and decommissioning of defense nuclear facilities. One of the most encompassing of these recommendations was Recommendation 95-2. The major thrust of this recommendation was to bring the many safety-related directives, implementation efforts, and new initiatives related thereto into a more cohesive, integrated, and effective safety management program, with clearer lines of responsibility and authority defined for its execution. The Board and DOE worked cooperatively to define an implementation plan for Recommendation 95-2, which was published on April 18, 1996 and have been working diligently to make Integrated Safety Management of defense nuclear facilities a reality. The Board notes with interest and a sense of satisfaction that the concept and principles of this upgrade program are being adapted to safety management of nondefense hazardous work as well.

In the spirit of cooperation that has marked this effort, the Board as a whole has been monitoring progress with open meetings and providing feedback through regular exchanges with the Assistant Secretaries of Environmental Management and Defense Programs. In addition, Board Member Joseph DiNunno, on behalf of the Board, has maintained close contact with the DOE team assigned to lead the DOE effort. He has prepared this paper as a way of sharing his vision of Integrated Safety Management and of raising issues that need to be addressed to move the program forward. The Board believes this paper will be informative to those not familiar with the concept of Integrated Safety Management and helpful to those laboring to make it a reality.

John T. Conway
Chairman

ACKNOWLEDGMENTS

The author wishes to express appreciation for the opportunity to interact with all fellow Board members on this topic and for the help of any number of the Board's staff. Special thanks is given to my colleague Herbert J. C. Kouts and to the following staff: Farid Bamdad, Dan Burnfield, Jay DeLoach, Steve Krahn, John MacEvoy, Cindy Miller, Don Owen, and Jan Preston. Bruce Graham assisted with graphics, and Deatrice Ruff word processed my scrawls into legible type.

TABLE OF CONTENTS

TABLE OF CONTENTS (concluded)

LIST OF FIGURES

Figure **Page**

LIST OF TABLES

Table **Page**

1. INTEGRATED SAFETY MANAGEMENT

1.1 PURPOSE

This paper discusses the background, rationale, and concept of treating the environmental, health, and safety programs of DOE as an integrated whole. That is the central theme of Recommendation 95-2 presented to DOE by the Board on October 11, 1995.

DOE accepted the recommendation and developed, in cooperation with the Board, a plan to move forward toward implementation. Initial efforts are directed at ten priority facilities. In parallel, DOE is moving to institutionalize this concept, to make it applicable across the complex for all its nuclear activities.

The goal we all seek is an improved safety management program. The actions towards that end as set forth in the 95-2 Implementation Plan (Department of Energy, April 8, 1996) are progressing well.

The ideas and concepts presented herein are intended to contribute to the success of those activities.

At points in this report, challenges are identified. These are specific objectives that need to be attained if an Integrated Safety Management is to be realized.

1.2 BACKGROUND

1.2.1 Early Developments in the Atomic Energy Commission

The current safety program of DOE reflects the historical evolution of requirements laid upon DOE and its predecessor agencies by Congress in the interests of protecting the environment and the health and safety of the public and workers.

When the Atomic Energy Act (AEA) was initially passed (1946) and subsequently amended (1954), its major safety concern, other than national security, was protection of the public and property. The Act focused on the potential for inadvertent exposure of the public to the radioactive materials that were being produced and applied in weapons production and later in a variety of civilian applications. Both security and public safety considerations led to placement of such activities in relatively isolated locations. Early experiences led to a base of common understanding among the weapons community of what was needed not only to provide reasonable assurance that the public was protected, but also to protect workers. This base of understanding grew over the years and was extended to the civilian program as that program expanded and became subject to external regulation. During the early years (1946–69) of development of the regulatory program, the principal regulatory focus was on nuclear radiation and protection of the public from any effects of such radiation. Worker and environmental protection relied mostly on such good practices as the government contractors brought to their efforts. These safety practices were not inconsiderable, for industrial giants such as Dupont at Savannah River and Union Carbide at Oak Ridge brought much good in-house experience to their tasks. Much of the practice was captured and codified by the regulatory staff of the Atomic Energy Commission (AEC), a predecessor of DOE, in the 1960s. For example, the concept of identifying those systems important to safety and those operational limits within which they must function to ensure safety was deeply embedded in the Dupont way of doing hazardous work. A similar safety philosophy was advanced by the Navy Nuclear Program.

One of the most ambitious and successful attempts to capture the best of nuclear safety concepts of the time led to the publication under AEC sponsorship of *The Technology of Nuclear Reactor Safety* (Thompson, 1964). The goals for reactor safety set forth therein (Vol.1:2) are as relevant today for all hazard Category I and II nuclear facilities and operations as they were for reactors then. For that reason they are quoted here:

> [s]afety should be aimed towards achieving the following goals, in the listed order of importance:
>
> (1) There must be no release of radioactive material in dangerous quantities from a nuclear facility to the general public. —There must be no "Public Safety Accidents."
>
> (2) The likelihood of a serious accident which would result in severe damage to a nuclear facility should be kept as small as possible. . . . The "Economic Accident" should be prevented.
>
> (3) Every reasonable effort should be made to eliminate accidents involving plant employees. —The frequency of the "Industrial Personnel Accident" should be reduced to the lowest possible level, certainly lower than that of other comparable industries.
>
> (4) System malfunctions and deviations from normal behavior should be reduced to a minimum, especially since a system with minor faults is more likely to develop major ones. —The number of "Operational Problems" should be kept to a minimum.
>
> Designers, builders and operators of reactor facilities . . . must be concerned with achieving all four goals.

1.2.2 Effects of Environmental Legislation

DOE's outlook on safety—indeed that of the entire federal structure—began to broaden with the passage of the National Environmental Policy Act in late 1969. Congress followed this landmark legislation with other major environmental protection statutes, including the Federal Water Pollution Control Act ("Clean Water Act") (1977), the Clean Air Act (1977), the Toxic Substance Waste Control Act (1976), the Solid Waste Disposal Act (1974), and the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) (1980). These statutes reflected national concern over the effects of industrial and ordinary human actions on our environment, and they enlarged the statutory safety and environmental obligations of DOE well beyond those prescribed by the Atomic Energy Act.

The health implications of hazardous materials and the need for controls over how and where they were developed and used in our society brought the workplace into sharper focus. Occupational safety and health, heretofore driven largely by the economics of achieving safety in the workplace, became subject to codified practices administered by the Occupational Safety and Health Administration (OSHA) of the Department of Labor (1970).

Prior to the Occupational Safety and Health Act (OSH Act), the AEC regulated its contractors' work practices in accordance with provisions of the Atomic Energy Act. Congress exempted federal agencies from the OSH Act in 29 U.S.C. § 653(b)(1), but the President, in Executive Order 12,196, reinstated the requirement when he decided to apply OSH requirements to all Executive Branch agencies. The latter agencies, including DOE, must now implement occupational safety and health programs substantially similar to those required by the Department of Labor for commercial entities, as did DOE's predecessor agencies, AEC, and the Energy Research and Development Administration (ERDA). Employees at DOE-owned, contractor-operated facilities would be subject to Labor Department regulation but for 42 U.S.C. § 2201(i) (Atomic Energy Act § 161(i)), which authorizes DOE to regulate health and safety at its facilities. In 1974, the Department of Labor granted an exemption to AEC/ERDA from regulation by OSHA for worker protection at facilities constructed and operated under the Atomic Energy Act. As a part of that action, AEC committed to providing worker protection at such facilities consistent with that provided under the OSH Act in the private sector. This exemption was retained when the AEC was reorganized to form ERDA and subsequently DOE.

DOE, under provisions of the Atomic Energy Act (1954), is authorized to:

> Establish by rule, regulation or order such standards and instructions to govern the possession and use of special nuclear material and by-product material as the Commission may deem necessary or desirable to promote the common defense and security or to protect or to minimize danger to life or property.

In keeping with this authority, DOE has issued safety requirements in rules (regulations) and in DOE safety orders (Orders). Requirements in rules are mandatory unless there is formal exemption, whereas those in Orders are mandatory when the contract so states.

The provisions of the Atomic Energy Act do not exempt DOE or its contractors from provisions of other environmental protection legislation, including those requiring permitting of routine releases of radioactive materials into the air or sources of drinking water, and the disposal of mixed solid wastes. The requirements and implementation guidelines issued by DOE in keeping with the agency's statutory responsibilities under the Atomic Energy Act, together with its compliance responsibilities under other environmental protection statutes, form a standards base upon which DOE's contractors are expected to structure and implement their safety management programs.

1.2.3 DOE's Environmental, Safety and Health Program

Detailed background on the present Environmental, Safety and Health (ES&H) program of DOE (hereafter referred to as the Safety program), including events leading to the establishment of the Defense Nuclear Facilities Safety Board, is provided in the DOE document, *Closing the Circle on the Splitting of the Atom.* (Department of Energy, January 1995). The principal reason for this brief summary of this background to development of the existing situation is to give emphasis to several points, namely:

- DOE's Safety program has evolved from codes of practice brought by its early contractors to the accomplishment of DOE's assigned mission. Prior to the early 1970s, little codification and little cross-fertilization of safety programs occurred across sites. Protection of the public and workers was achieved with reasonably good success, particularly after the shift from atmospheric testing of nuclear weapons to underground testing. However, success in weapons development and production was achieved at the expense of the environment. Among the by-products were radioactive wastes, unstable residual materials, contaminated facilities, and contaminated sites.

- Early attempts to codify and implement good practices across the complex focused on radiation as the dominant hazard. Protecting the public and preventing fatalities or major disabling injuries among workers were the primary objectives for preventive and mitigative controls.

- DOE's Safety program has developed in parts: protection of the public, protection of workers, protection of the environment, protection of property, and safeguards and security (not necessarily in sequence).[1] The development occurred partially in

[1] Safeguards and security are not addressed in this document, but in reality should be considered by DOE in its Integrated Safety Management program.

response to several statutes, which were enacted separately, and partially in response to individual proclivities of the various administrators of environmental protection programs. One of the most regressive safety practices introduced in the 1970s by federal administrators was the division of hazardous work planning into parts—one part to be done by those who engineer the systems and processes for doing work, and another by those who evaluate the safety and environmental implications. This practice was instituted in reaction to evidence that planning by those dedicated to mission objectives frequently had not provided adequate protection.

- Organization of the administration of DOE's Safety program has been structured to correspond to the major safety statutes. A safety system developed in parts has been administered in parts.

It is against this background that the Integrated Safety Management program advocated by the Board in Recommendation 95-2 should be viewed.

1.3 RECOMMENDATION 95-2

The Board in Recommendation 95-2 recommended that DOE:

1. *Institutionalize the process of incorporating into the planning and execution of every major defense nuclear activity involving hazardous materials those controls necessary to ensure that environment, safety and health objectives are achieved.*

2. *Require the conduct of all operations and activities within the defense nuclear complex or the former defense nuclear complex that involve radioactive and other substantially hazardous materials to be subject to Safety Management Plans that are graded according to the risk associated with the activity. The Safety Management Plans and the operations should be structured on the lines discussed in the referenced documents DNFSB/TECH-5* (Defense Nuclear Facilities Safety Board, May 31, 1995) *and DNFSB/TECH-6* (Defense Nuclear Facilities Safety Board, October 6, 1995).

3. *Establish a new list of facilities and activities prioritized on lines of hazard and importance to defense and cleanup programs, to focus the transition from implementation programs related to 90-2 and 92-5 to this revised development of S/RIDs and associated Safety Management Plans, following the process of Section I of DNFSB/TECH-6.*

4. *Promulgate requirements and associated instructions (Orders/standards) which provide direction and guidance for this process including responsibilities for carrying it out. The manner of establishing*

responsibilities and authorities as currently set forth in DOE Order 5480.31 (425.1) for Operational Readiness Reviews should serve as a model for preparing, reviewing, and approving the Safety Management Programs. The requirement for conformance should be made a contract term.

5. *Take such measures as are required to ensure that DOE itself has or acquires the technical expertise to effectively implement the streamlined process recommended.*

1.3.1 The Implementation Plan

The Board and DOE then collaborated to develop a plan to implement Recommendation 95-2. The plan included integration of a number of initiatives in progress within DOE at the time. These initiatives had been taken in response to previous Board recommendations and others responded to various other external pressures for change in practices. The latter included the Galvin Report (Galvin, February 1995), the National Performance Reviews (Gore, 1995), and congressional revisions of the Atomic Energy Act in the Price-Anderson Amendment Act of 1988 applicable to DOE contractors. The common objective of the implementation plan was "Do Work Safely." The Board and DOE agreed upon the following five basic functions as essential to planning and performing hazardous work safely (see Figure 1):

- Define the work and how it is to be accomplished.
- Analyze the hazards entailed in performing the work.
- Identify the controls necessary to perform the work safely and include them in design and operational procedures.
- Perform the work as planned, using adequately trained personnel.
- Assess how well the system worked, and feed back the evaluation results to reinforce and improve the process.

While these functions represent a common-sense approach (Howard, 1996) to planning and performing virtually all types of hazardous work, large or small, the results of such planning in the form of safety controls will vary to suit the diversity of hazardous work that must be performed by DOE and its contractors. Accommodating that diversity is one of the major challenges for transitioning effectively to Integrated Safety Management within DOE.

Safety Management Functions

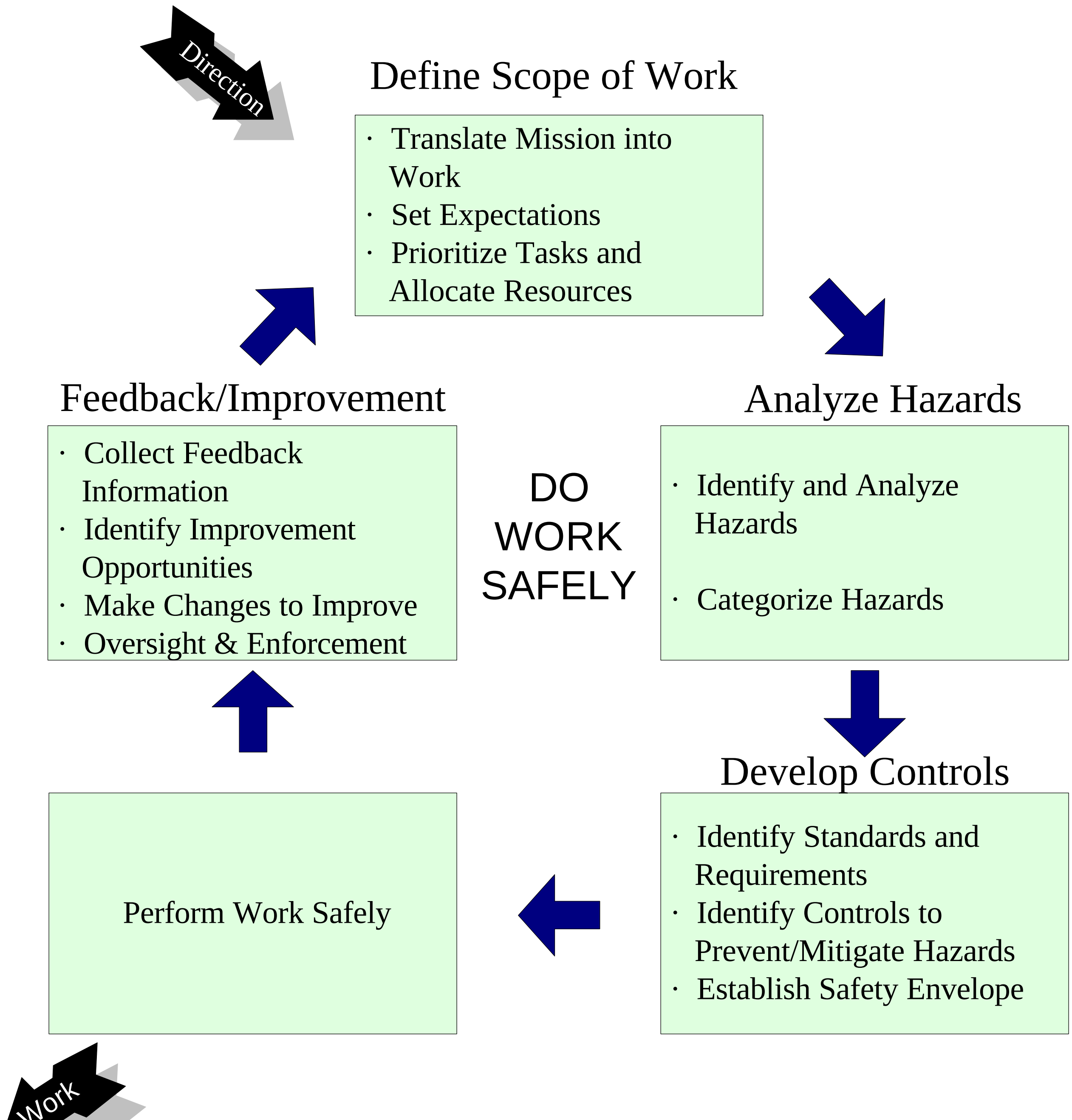


Figure 1. Safety Management Functions

The major thrusts of the effort DOE has committed to undertake in the Implementation Plan for Recommendation 95-2 are as follows:

- Upgrading the system of directives DOE uses in defining the safety obligations of its contractors.

- Making work planning and safety planning an integral process.

- Identifying more explicitly those requirements mutually agreed upon by DOE and contractors to be applicable to the specifics of a contractor's work, and establishment by the contractors of implementing procedures.

- For all hazardous work, defining safety control measures tailored to the specifics of the work and the protection of the environment, the health and safety of the public and workers, and protection of government property. Such controls are to be subject to DOE compliance and enforcement.

- Establishing appropriate protocols for DOE to apply in reviewing and accepting contractors' programs of safety control and protection of the public and the worker.

- Enhancing the qualification and training of the workforce, to foster a safety culture and provide in the workforce a level of skill commensurate with the need to work safely.

- Regularly assessing the effectiveness of safety programs and feeding back lessons learned to effect improvements in equipment and procedures.

1.3.2 The Fundamental Challenge

CHALLENGE: The fundamental challenge is to make Integrated Safety Management a reality. While there appears to be wide acceptance of the concept of Integrated Safety Management as described above and general agreement with the basic thrust of the upgrading efforts, particularly the opportunity to tailor safety programs, too few yet comprehend the level of effort and the change in roles required of the federal work force and the contractors to make such a system function effectively.

The discussion that follows is intended to highlight a number of subsidiary challenges. These should serve as a focus for dialogues held by the Board and the staff with DOE, in the interest of achieving the objectives of Recommendation 95-2**.**

2. STANDARDS-BASED SAFETY MANAGEMENT

DOE performs a large part of its defense nuclear mission through contractors. Much of the responsibility for safe operation of the facilities that comprise the defense nuclear complex has been delegated to these contractors. Through such delegation, this responsibility becomes shared but not relinquished by DOE. In policy statement P-450.4 dated May 1996, DOE sets forth a number of objectives and principles relative to safety management. Among the latter, DOE reaffirms the principle that DOE line managers are responsible for ensuring the safety of those operations that have been assigned to them.

DOE has also identified in a set of directives what it expects its contractors to do relative to protecting the public, the environment, workers, and property. DOE's commitment to a "standards-based" safety program represents a commitment to the safety concepts reflected by these directives.

Articulation of objectives and principles is important, but not sufficient, to achieve effective safety management. The challenge for DOE in restructuring its safety directives is several fold.

2.1 DOE's BASIS FOR ESTABLISHING REQUIREMENTS

CHALLENGE: To set up a requirements base for contractors that can be adapted readily to the diverse activities that are to be performed, yet ensure the protection of the public, workers, and environment, for which DOE retains ultimate responsibility.

DOE's current directives relevant to safety management of its nuclear facilities include policy statements, regulations, Orders, notices, manuals, guides, and technical standards. DOE has issued interpretative documents to supplement these, and DOE has encouraged also its contractors to use industry consensus technical standards where applicable.

DOE and the Board recognize that the combination of all guidance and all of the explicit requirements in these directives are not universally applicable to the diverse hazardous activities performed by DOE contractors. Both DOE and the Board recognize the need for DOE's contractors to identify and implement, as a base for Integrated Safety Management those requirements and associated practices which best fit their assigned missions.

In attempting to comply with this compendium of directives and interpretations, contractors are faced with a number of very practical problems in structuring the base requirements for safety management programs.

First, the DOE directives system incorporates certain binding requirements, as well as other nonbinding guidelines that are frequently also called requirements, numbering in the

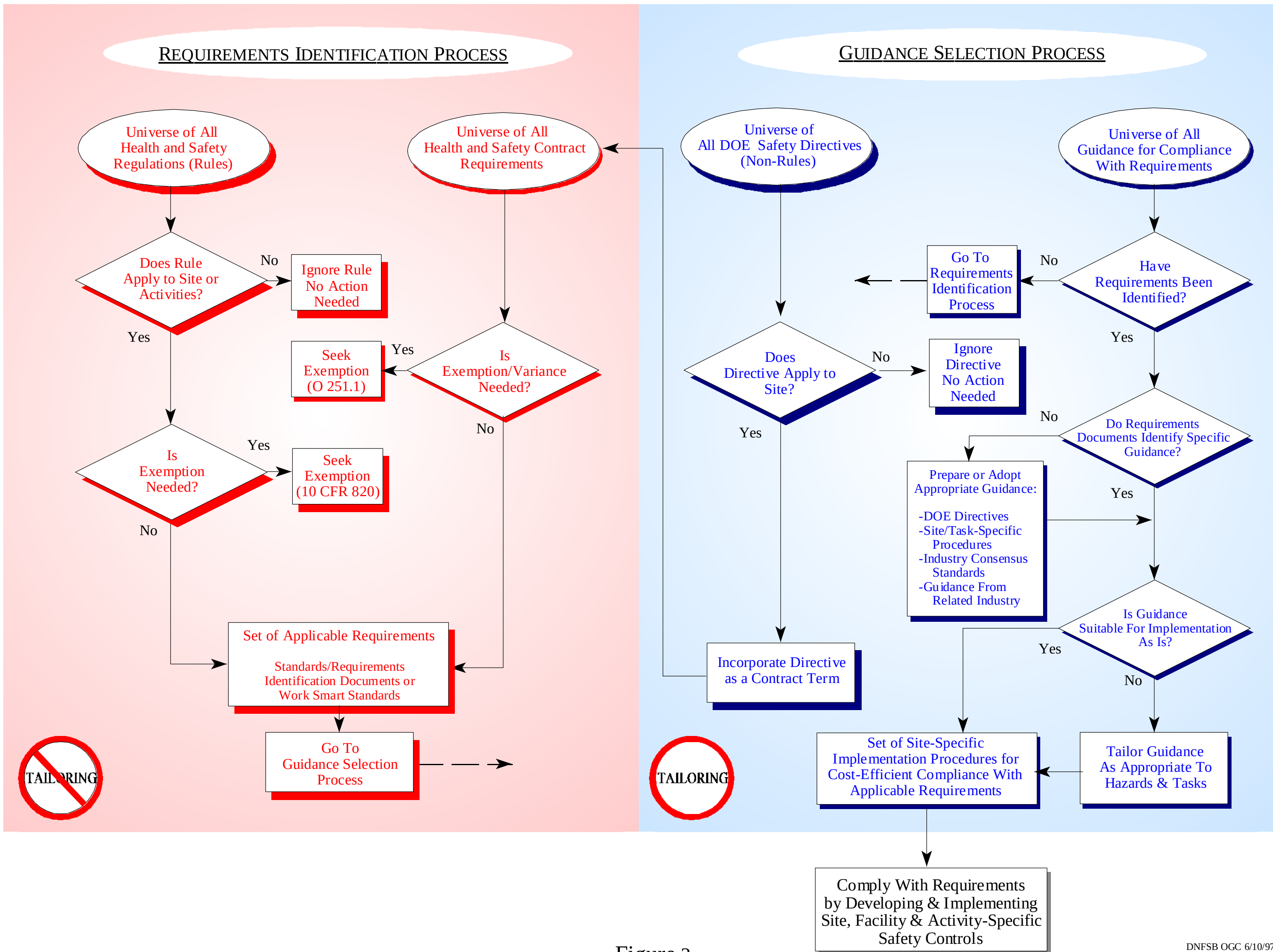


Figure 2.

DNFSB OGC 6/10/97

thousands. Figure 2 shows the division between binding requirements (red area, consisting, e.g., of statutes, regulations, and mandatory contract terms) and guidelines (blue area, consisting, e.g., of nonbinding requirements in DOE safety Orders and other documents, such as DOE and industry consensus technical standards, DOE policy, and other issuances). Since the term "standards" as frequently used includes both binding requirements and guidelines, more precise terms (e.g., "statutes," "regulations," "industry consensus standards") will be used here to avoid confusion; the term "requirements" as used here denotes binding requirements.

Second, not all requirements or guidelines apply to a given site, facilities within the site, or individual tasks at facilities. Therefore, of the universe of all requirements and guidelines, contractors and DOE must identify those which are *applicable* and will serve as the base for individual site-wide Safety Management programs. Once the set of applicable requirements and guidelines has been identified, contractors are expected to establish the implementing procedures (manuals of practice) needed to adapt the guidelines to specific site and task needs, which may involve adding guidelines if appropriate. Figure 2 shows a logic diagram for the identification and selection of regulations, contract requirements, DOE directives, and other guidelines. Statutory requirements are not shown on this figure because they are usually reflected in more detail in regulations. However, applicable statutes must be identified as part of a requirements identification process.

Finally, relief from requirements established as generally applicable by regulation involves different processes than for relief from requirements established by contract (i.e., rules vs. Orders). Only a small subset of the regulations in the Code of Federal Regulations (CFR) applies to DOE, and of those, not all apply to individual DOE sites, facilities, and tasks. Exemptions are not necessary for clearly inapplicable regulations. However, if a site, facility, or specific task falls within the scope of a regulation, compliance is required unless an exemption is sought and granted under the appropriate process (under the requirements of 10 CFR Part 820, for example). Tailoring of such regulations is not an option. (As will be discussed, specific *methods of compliance* with regulations may be tailored, unless a specific method is directed by regulation.) Thus, the regulations base for the Safety Management program include the set of all applicable regulations, and no exemptions are needed to eliminate clearly nonapplicable regulations from this set.

DOE safety Orders, as well as some DOE manuals, contain guidelines that are labeled as requirements, but are not binding on contractors. These guideline-requirements can be made binding on contractors by incorporation as contract terms. (This contrasts with applicable statutes and regulations which are binding on contractors merely by their scope; incorporation in a contract is irrelevant.) As shown in Figure 2, not all Orders are applicable to a site, a facility, or a work activity. Like inapplicable regulations, these inapplicable directives may be excluded from further consideration. Applicable guideline-requirements in Orders *should* (as opposed to *must*) be included in the contract as requirements, but *may* be omitted if justified by the tailoring process if that process is accepted by DOE.

Once a guideline-requirement has been converted to a binding requirement by incorporation as a contract term, contractors must follow formal processes to seek relief from a requirement if they decide that it is no longer necessary. The process for exemption from contract health and safety requirements varies with the contract and the directive containing the requirement. The contractor at the Savannah River Site, for example, seeks an exemption from a requirement according to the process in the directive (usually DOE safety Order) containing the requirement, then modifies the contract with the concurrence of the contracting officer.

Contract requirements, plus applicable regulatory and statutory requirements, make up the set of binding requirements applicable to a site, facility, or task. *Methods of compliance* with the requirements must now be selected or developed. Guidance documents providing recommended methods of compliance abound, in the form of DOE directives and other documents, industry consensus standards (in many revisions), and relevant materials from other government agencies. Some guidance documents may be referenced directly by a regulation, while others may be prepared for the express purpose of providing acceptable methods of compliance with a given regulation or DOE Directive.

2.2 RULES vs ORDERS

CHALLENGE: To respond to pressures to establish substantive, safety requirements through rule making while not unduly encumbering (1) the process of identifying the set of requirements that will form the base of the contractor's Integrated Safety Management program and (2) the tailoring of safety measures to the specifics of the hazardous work to be performed.

For the past several years, DOE has been under pressure to reduce requirements while restructuring its directives relevant to nuclear safety management activities (Galvin, February 1995; Gore, 1995). DOE has directed much of the restructuring effort toward converting provisions labeled as requirements in DOE safety Orders to regulatory requirements, i.e., rules.

As pointed out in the last section, "requirements" in safety Orders are not binding on contractors until incorporated in contracts as recognized requirements, but rules are binding on contractors when promulgated, provided the contractors and activities clearly fall within the scope of the rules. Because of this difference, safety Orders offer the system of DOE and contractors more flexibility in selecting which requirements become binding for specific sites and activities. However, once requirements become binding, either through incorporation in contracts or promulgation as rules, formal exemption processes must be followed to seek relief. Exemption processes for requirements established by rules are different from those for requirements established as contract terms. Which process is more onerous depends on how DOE implements its processes for exemption. In either case, DOE retains flexibility to tailor its methods of compliance to be cost effective.

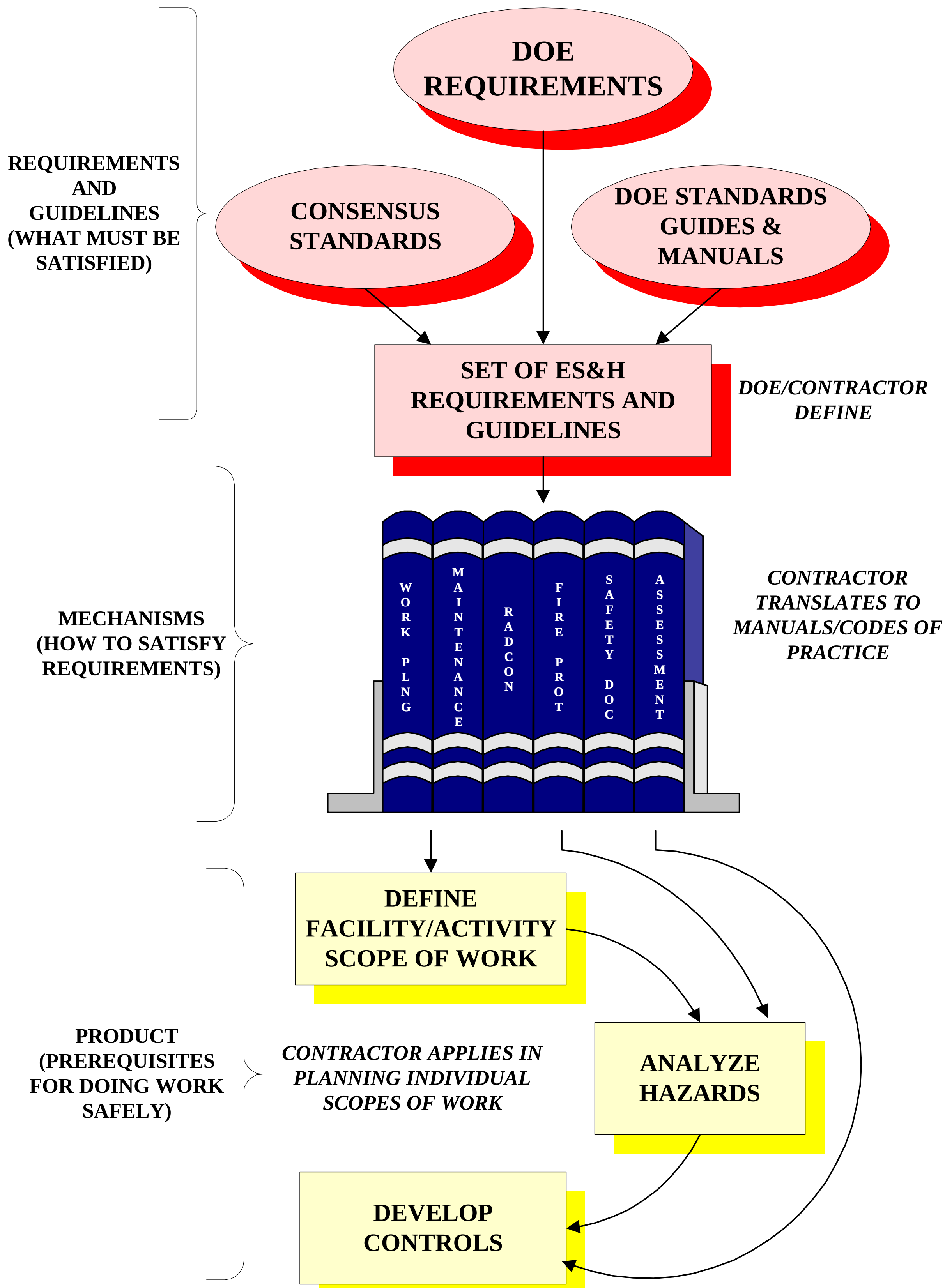
Binding requirements, whether rules or contract provisions, subject contractors to the potential for noncompliance penalties, both criminal and civil. Civil penalties can actually be higher under contract actions, but specific circumstances will dictate the results. There are indications that some contractors prefer establishing requirements by contract rather than by rule because of potential criminal sanctions under the Price-Anderson Amendment Act. Such perceived benefits may be mostly illusory, however, since criminal sanctions can be applied in either case for deliberate and willful wrongdoing under 18 U.S.C. §§ 1001 and 1002.

2.3 IMPLEMENTATION

CHALLENGE: To require contractors to establish effective actions in accordance with requirements mutually agreed to be applicable.

A requirements base must be mutually agreed upon between contractor and DOE as the foundation for a site-wide Integrated Safety Management program. Establishment of this requirements base is essential but not sufficient for effective safety management. The contractor must also develop and commit to implementing procedures, which are referred to in DOE policy statement P450.4(a) as "mechanisms." They are frequently provided in the form of manuals of practice. Some sites (e.g., Pantex) have referred to these as "standards" and to the site-wide program as the "Essential Standards" program. The flowdown from DOE requirements to contractors' implementing procedures (manuals of practice) is illustrated in Figure 3. The generic flowdown is farther illustrated (Figures 4 through 7) by overlays of DOE requirements. Each overlap shows a site-specific set of implementing procedures for performing facility-specific hazardous work. The ultimate objective of all these requirements and implementing procedures is the set of control measures judged necessary for the specific hazardous work conducted to protect the public, workers, and the environment.

Figure 4 shows an example of the functional areas covered by requirements in DOE Orders and rules for developing control measures, and Figure 5 identifies DOE Orders and rules generally applicable to these areas. Figure 6 and Figure 7, respectively, identify implementing procedures prepared as manuals of practice by contractors for the Savannah River Site and Lawrence Livermore National Laboratory in response to these generally applicable rules and Orders. The implementing procedures (manuals of practice) shown in Figures 6 and 7 are further detailed in Tables 1 through 3. Table 1 lists the implementing procedures of the Savannah River contractor as a matrix structured according to the guiding principles set forth in DOE policy statement P450.4.



Standards-Based Safety Management
Figure 3

FUNCTIONAL AREA

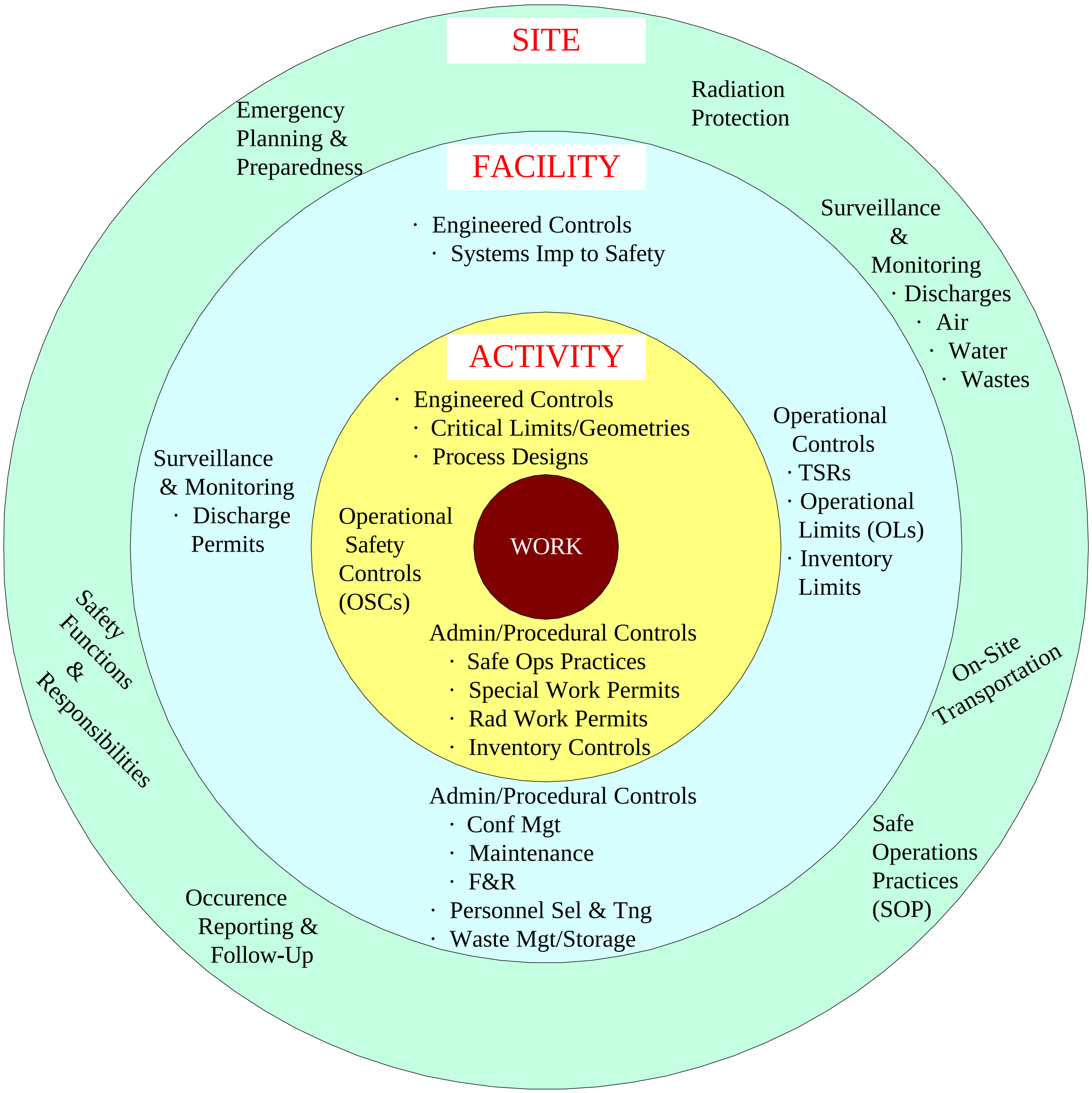


Figure 4.

DOE SAFETY RULES AND ORDERS

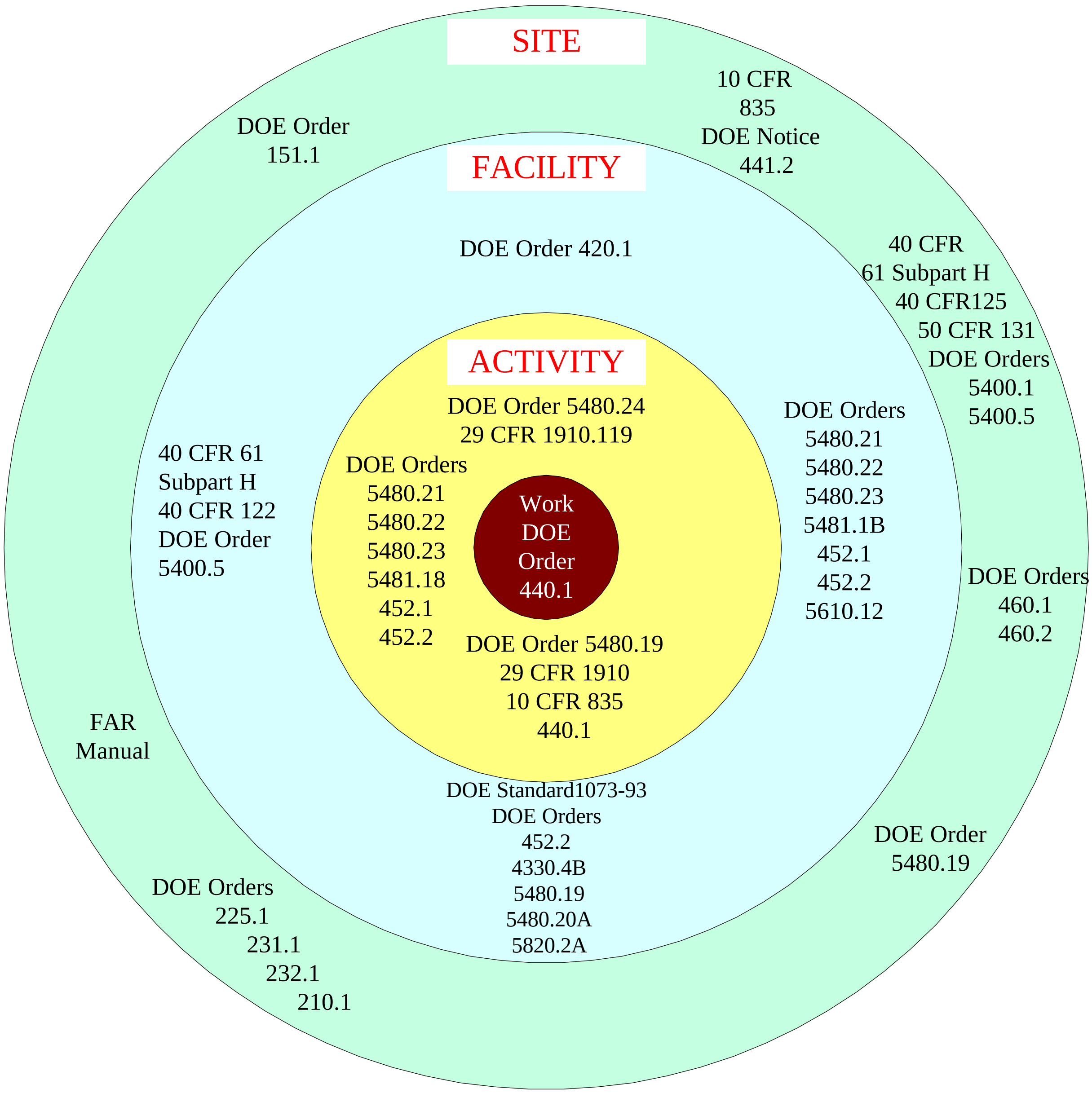


Figure 5

IMPLEMENTING PROCEDURES
WESTINGHOUSE/SAVANNAH RIVER

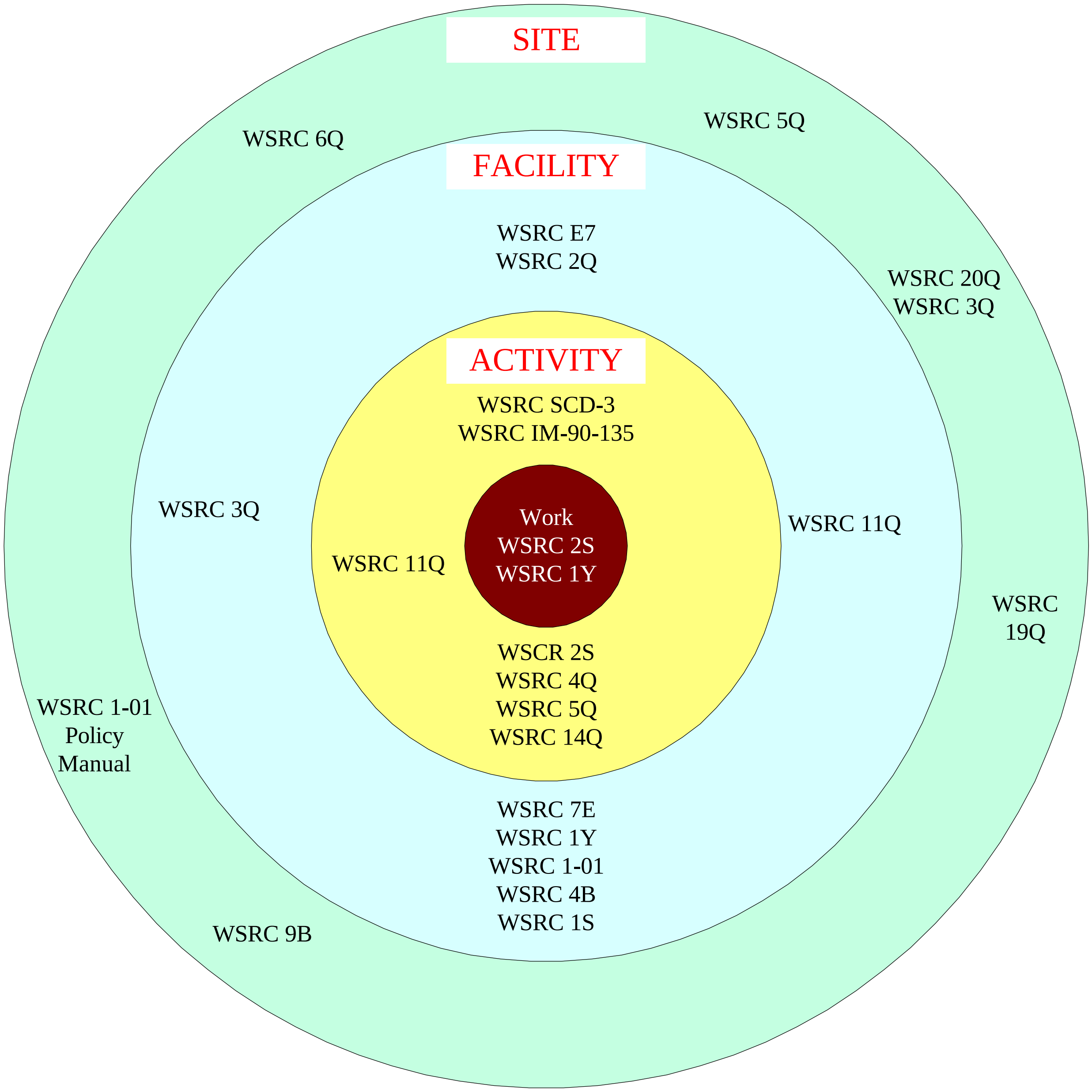
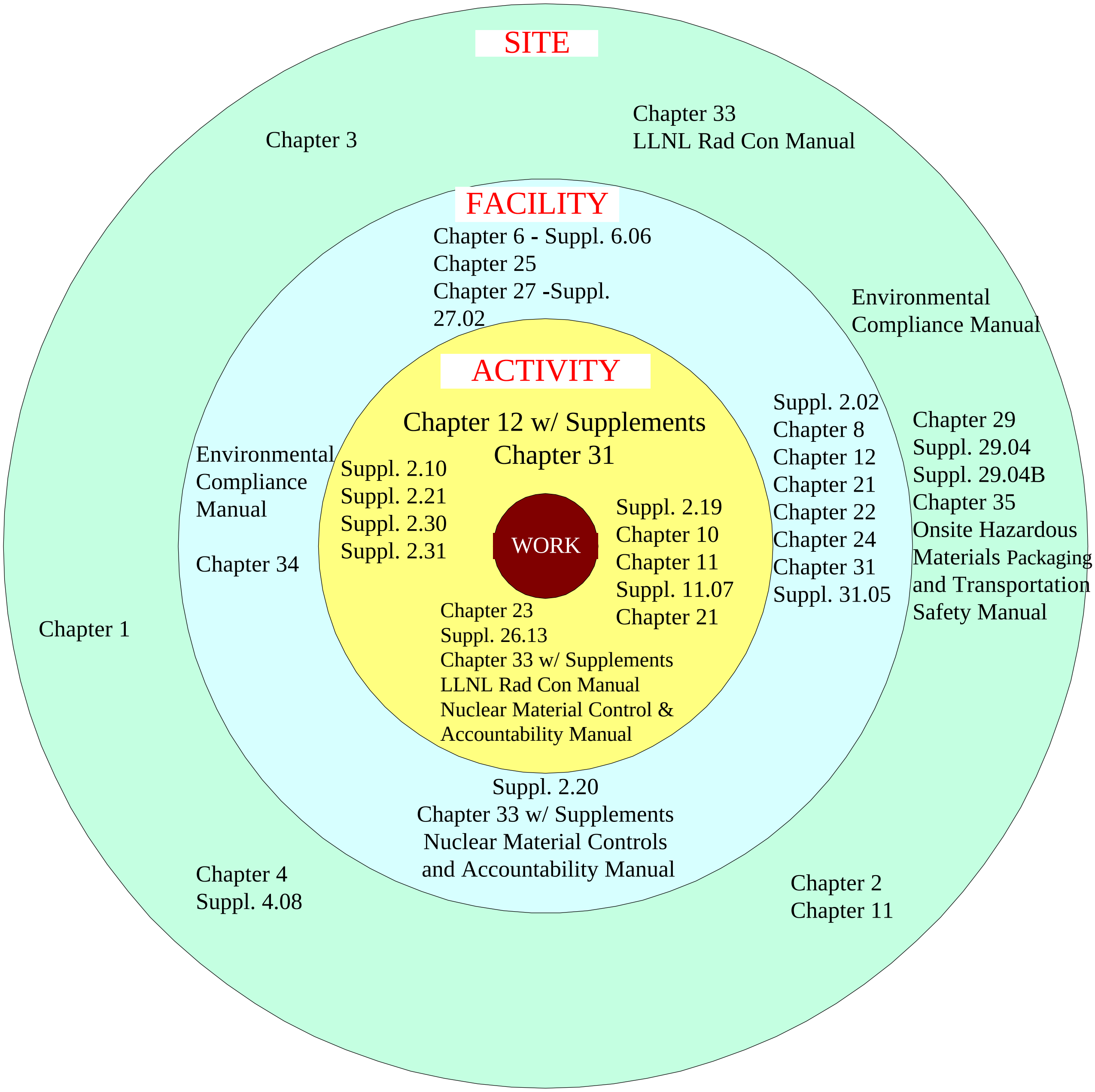


Figure 6

LLNL IMPLEMENTING PROCEDURES
BUILDING 332



ES&H Manual:
Environmental Compliance Manual
Subsidiary Guidelines
Health and Safety Manual
Supplements to the Health and Safety Manual

<u>LEGEND:</u>
Chapter: Chapter of LLNL's Health & Safety Manual
Suppl.: Supplement to the LLNL's Health & Safety Manual

Figure 7.

3. INTEGRATION OF WHAT?

As noted in Section 1, the Board and DOE have collaborated to develop a plan for implementing the concept of Integrated Safety Management. The five basic safety management functions agreed to be essential for doing radiological work safely (Figure 1) require consideration of a multiplicity of variables and the integration of safety control measures resulting from a process of selecting applicable requirements. A brief discussion of these variables follows.

3.1 WORK PLANNING AND SAFETY PLANNING

3.1.1 How Engineering Analysis and Environmental Analysis Became Separate Activities

The first successful applications of nuclear materials for both weaponry and peaceful uses were marked by a close working relationship between the persons developing the science of nuclear reactions and those engineering the applications. Dealing with the safety implications of the radioactive nature of the materials was very much an integral part of the engineering challenge. With the growth of civilian nuclear power in the 1960s, however, a divergence began as the licensing process started to require more and more sophisticated analysis of potential accident scenarios and the definition of measures for dealing with them. Nuclear safety analysis soon became a specialty field.

This divergence was accelerated by passage of the National Environmental Policy Act (NEPA) and the issuance of federal guidelines for compliance, and by the ERDA/Nuclear Regulatory Commission (NRC) partitioning of AEC in 1974. The Administrator of ERDA during this period interpreted such guidelines as encompassing a requirement to separate the planning of work (engineering a solution to a problem or functional task) and the environmental impact assessments for the technical alternatives available for potentially hazardous work. Those who were charged with the responsibility for weapons production or other uses of nuclear materials, in effect, were not to be trusted to evaluate objectively the environmental implications of those activities. Environmental impact analysis emerged as a speciality field—a field some have termed a “cottage industry.” This trend received further impetus from the passage of other environmental protective legislation, such as the Clean Air Act, the Clean Water Act, the Toxic Substance Control Act, and the Solid Waste Disposal Act.

3.1.2 Integrating ES&H and Design

CHALLENGE: The challenge is to organize the work planning function so as to bring to bear in an integrated way specialists in both ES&H and engineering.

Currently, neither the programmatic staff of DOE Headquarters nor that of the Field Offices is organized to administer their contractors’ work planning and safety planning as an integral process. Much of the expertise in ES&H within DOE Headquarters is not found in organizations having line responsibility. Line managers of both DOE and contractors must take the lead in seeing that ES&H expertise is brought to bear in a much more direct way in support of those programs/activities for which they are held responsible. This means direct involvement of line management in seeing that contractors develop and effectively implement an Integrated Safety Management program that is tailored to the hazards of the work they have contracted to perform. This means also that those responsible for engineering the processes (e.g., weapons assembly/disassembly, nuclear material fabrication/stabilization, criticality experiments, waste storage) must be given more direct responsibility for hazard analysis, for the provision of safety control measures derived therefrom, and for the effectiveness of these measures.

3.2 INTEGRATION BY SITE, FACILITY, AND ACTIVITY

The five basic safety management functions identified in the Implementation Plan for Recommendation 95-2 are equally applicable to all hazardous operations, regardless of the level of the work. This is an important point, because the work at the various DOE sites must often be planned and performed at quite different levels. These include, for example, (1) tasks accomplished at a minor level, such as replacement of a valve or instrument, (2) an assembly line operation such as at Pantex for weapons disassembly, (3) operations in facilities with a multiplicity of diverse activities, such as at research laboratories (for instance Technical Area-55 [TA-55]), and (4) work performed under controls applicable to a site as a whole.

Some safety requirements, such as radiation protection and emergency planning, are often satisfied through implementation programs at the site level; others, such as configuration management and conduct of operations, by programs at the facility level; and still others by programs at the activity or task level. Work is always done at the activity and task levels.

> ***CHALLENGE: The challenge is to ensure that safety control measures pertinent to work at the activity/task level are brought to bear on that work even where some controls have been defined at the site level, others at the facility level, and still others at the activity/task level.***

This concept is illustrated by Figures 3 through 7 presented earlier. Similar illustrations have been shared with the Board by various DOE contractors when they reported on the status of their actions to develop Integrated Safety Management programs for the priority facilities identified in the Implementation Plan for Recommendation 95-2.

3.3 INTEGRATION OF CONTROLS BY SECTORS: WORKER, PUBLIC, AND ENVIRONMENTAL

As mentioned briefly in the background section of this paper (Section 1.2), the safety considerations of DOE have grown from an early emphasis on protecting the public and property to a much more encompassing set of protected sectors. Historically, DOE and its predecessor agencies structured programs to be responsive to the sector focus at the time—public, workers, environment. In effect, DOE developed requirements that treated these sectors as if they were independent, and accepted responses from contractors that were equally fragmented. In realty the sectors are not independent. The hazards to the various sectors stem in large measure from the same materials and processes. Although the controls are derived from different considerations for each sector, all must merge at the workplace; that is, all controls must be in place to support the work to be performed. This point is illustrated by Figure 8. It is an important concept to bear in mind, for it can keep the planning effort in better focus. Each of the three sectors is discussed in the following subsections.

In the course of the discussion, possibilities of improvement will be stated. To an extent, the suggested changes would remedy certain inconsistencies and irrationalities in DOE's existing practices. To an extent they are also aimed at ensuring that the good safety record of the past is continued into the future, in spite of downsizing of work forces and the loss of highly skilled personnel with their institutional memory of the methods that have produced the good safety record.

3.3.1 Worker Protection

3.3.1.1 DOE's Requirements

DOE's requirements for worker protection programs to be established by its contractors, formerly set forth in DOE safety Order 5483.1A, are currently found in DOE Order 440.1, approved on September 30, 1995. DOE safety Orders are invoked by contract terms to be applicable. The key requirements in Order 440.1 particularly pertinent to the present discussion. Specifically, the contractor shall:

- Identify existing and potential hazards of the workplace and evaluate the risk of associated injury or illness of workers.

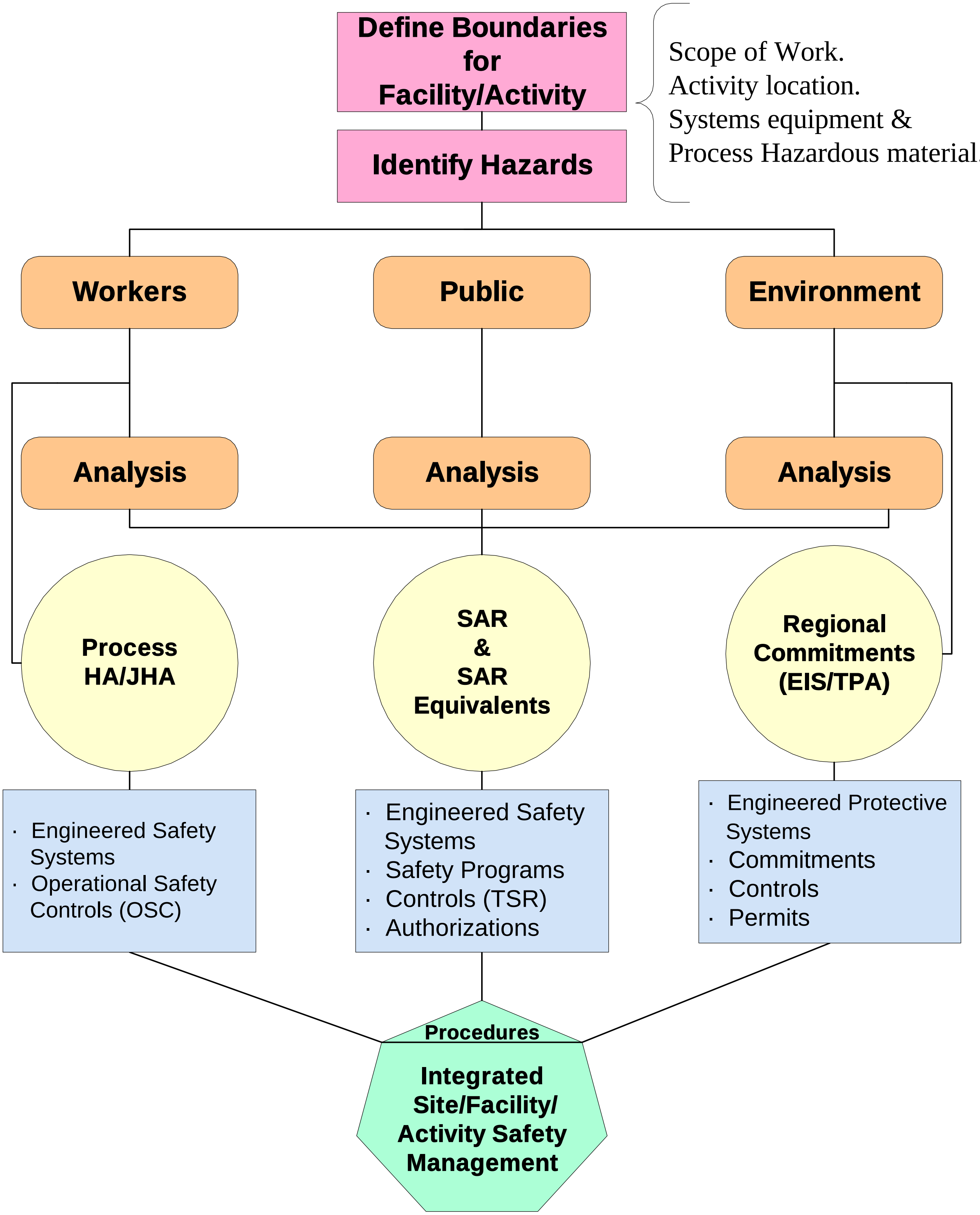
- Implement a process to ensure that all identified hazards are managed through a process of abatement or control.

- Select hazard controls based on the following hierarchy:

  Engineering controls
  Work practices and administrative procedures
  Personal protective equipment

- Comply with the "Occupational Safety and Health Standards" in 29 CFR Part 1910.

Radiological protection policy and practice have long been based on the principle that radiological exposures for workers should be kept as low as reasonably achievable (ALARA). A maximum cumulative annual exposure of 5 rem/yr has been recommended by national authorities,



Integration By Sectors
Figure 8

and 10 rem/5 yr, by international authorities. Reference dose criteria in use by DOE are consistent with these practices, as shown in Figure 9.

Achievement of these protective objectives for workers requires that all activities involving the use of radioactive materials must be analyzed to determine the specific hazards entailed and the measured response required to control or abate them. Similar analysis is necessary for other hazards (e.g., industrial, chemical, fire) associated with these activities. This need has long been recognized, and the requirement for performing such analysis has been codified (e.g., DOE Order 440.1 and 29 CFR 1910). What results in practice, however, is considerable variability in the way DOE's contractors satisfy the requirements for analysis, and this variability is even greater in the treatment of controls and abatement measures that are identified as a result of these analyses. Variability in itself is not necessarily an egregious flaw, but some methods are more effective than others, and all could benefit from sharing of experience in the interest of improvement and adaptation to the specific characteristics of a contractor's work.

A variety of hazard analyses are performed by DOE contractors in the interest of ensuring worker protection. These encompass much more than just radiological protection. Therein lies a complicating factor, because worker protection programs must reflect consideration of a multiplicity of potential hazards in the workplace, and requirements for doing so are established by different federal and state agencies.

3.3.1.2 Macro and Micro Levels of Analysis

DOE contractors' analyses of hazards to workers and the protective measures developed to prevent or abate them are conducted at both a macro and a micro level. This is illustrated in Figures 10 and 11.

The macro level is that represented by the Safety Analysis Report (SAR) or a tailored equivalent process. Tailored equivalents of the SAR include a Basis for Operation (BFO), a Basis for Interim Operation (BIO), a Justification for Continued Operation (JCO), a Nuclear Safety Explosives Study (NESS), and a Weapons Integrated Safety System (SS-21) Study. The Process Hazards Analysis required by rules of OSHA (29 CFR 1910.119, "Process Safety Management [PSM] Rule"; Occupational Safety and Health Administration, 1992) and the Environmental Protection Agency (EPA) (40 CFR 68, "Risk Management Program [RMP] Rule") may be considered to be SAR equivalents for high-hazard non-nuclear facilities.

These analyses and the control sets derived from them vary in depth and detail, largely as a function of hazard rating. The subset of worker protection controls established by the macro processes are typically a mixture of design features and administrative restrictions. They are directed at protecting workers from fatal or major disabling injuries. Nuclear criticality and chemical explosions are typical of the potential accidental events considered. Workers in the context of these macro processes include not only those doing hazardous work, but also those

RADIATION EXPOSURE ZONES

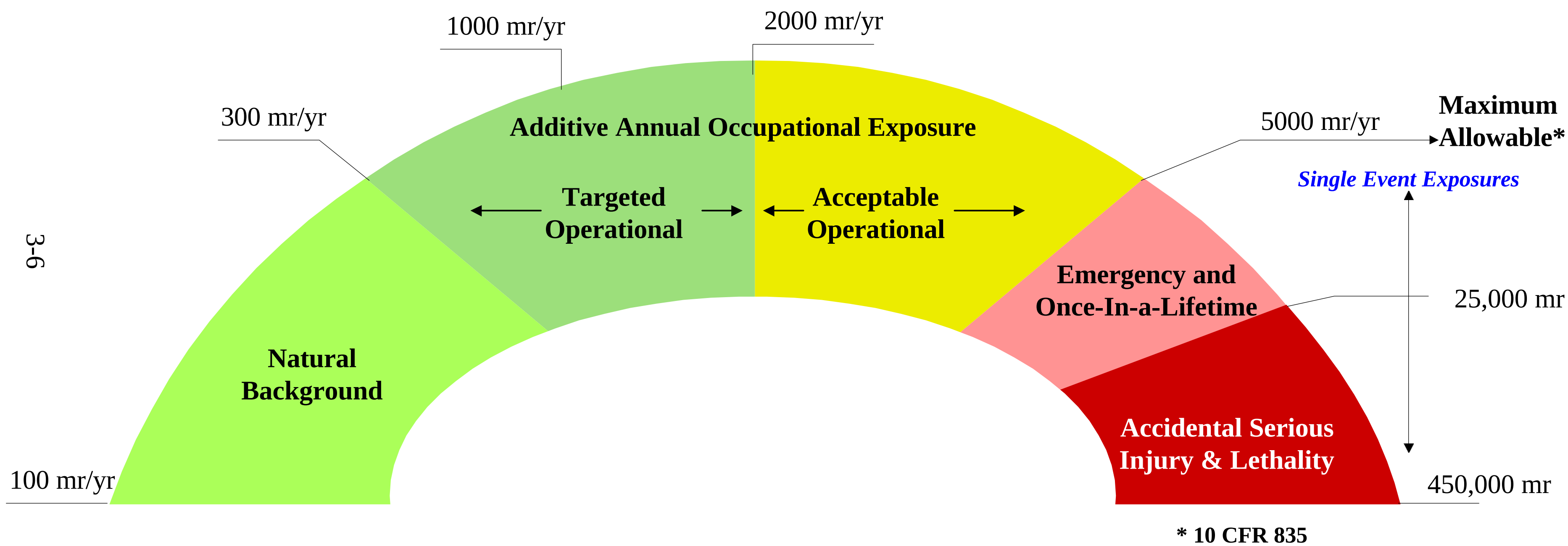


Figure 9.

collocated within the same facility or nearby in the same complex. Both the analysis and the resultant controls developed at the macro level are generally subjected to critical reviews by DOE.

The micro level is represented by the Job Hazard Analysis (JHA) or a tailored equivalent. Tailored equivalents that are being used by DOE contractors in detailed work planning at the activity/task level include a variety of processes for screening hazards and identifying controls, such as the Activity Control Envelope (ACE) (Rocky Flats Environmental Technology Site [RFETS]), the Job Requirements Checklist/Work Control Process (Idaho National Engineering and Environmental Laboratory [INEEL]), the Skill of the Craft process (Hanford), the Nuclear Explosive Hazards Analysis (Pantex), and the Hazards Analysis Report (Pantex). The subset of worker protection controls developed through these types of analyses is generally also a mix of design and administrative measures. These measures are directed at preventing lost time, physical injuries, and jeopardizing of health through undue exposure to radioactive or hazardous materials and other occupational hazards.

The requirements for ensuring worker occupational safety are imposed on contractors by rule and/or contract. DOE relies in large measure on the contractors to define and implement this subset of worker protective measures. Moreover, DOE's oversight in many cases has largely involved seeing that processes are in place, not routinely reviewing the products of those processes (i.e., Work Control Permits and Radiation Work Permits). This is not an unreasonable management concept for this level of detail, provided DOE ensures that an adequate worker protection planning process exists, DOE local authorities perform sufficient sampling checks to confirm satisfactory implementation, and the contractor is held to some sort of occupational safety performance measure.

Worker protection controls need to be specific to a wide variety of tasks. Processes for developing these specifics need to be adaptable to that same variety of tasks in order to optimize worker productivity and job safety. The basis for variants in developing protective measures at this level includes the nature of the hazards, the complexity of the tasks, the routine or nonroutine nature of the tasks, instructional guidance, worker skills, and worker supervision. The concept of tailoring control measures to hazards is illustrated by Figure 12.

3.3.1.3 Pre-Planning of Work

CHALLENGE: To achieve the end objective of enabling work to be done safely, hazardous work must be pre-planned, and workers must be instructed regarding both the engineered and administrative controls identified through hazards analysis/safety analysis.

DOE has an ongoing initiative (Department of Energy, 1996) aimed at improving the work planning processes of its contractors through the sharing of lessons-learned. This activity appears to produce some good results. Particularly encouraging is evidence of improvements at the micro level as discussed above, through such measures as the following:

- Concurrent engineering of work packages by multidisciplinary teams focused on planning the work and avoiding the hazards

- Line management leading the engineering, with a supporting role by ES&H

- Involvement of workers (operational)

- Linking of controls in procedures to hazard analyses

- Emphasis on design over administrative controls in order to reduce or eliminate the hazard in lieu of just reducing the possibility that workers will be exposed to it

As shown by Figure 10, there are four basic pathways whereby worker protection controls identified through hazard/safety analyses become operational requirements:

- Agreements reached between DOE and contractors as to specific controls to be exercised in performing radiologically hazardous operations. These are controls identified through the macro level of analyses discussed above.

- Radiological Work Permits that establish the task-specific radiological controls that are prerequisites for the conduct of work at a task level.

- Work Control Permits that establish task specific controls other than from radiation, that are also prerequisites for the conduct of the work.

- Operating Procedures that embody controls for protection of workers, the public, and the environment.

Controls identified in the last three items above are generally the result of hazard analysis at the micro level discussed above. What has been inconsistent at DOE sites is the degree to which appropriate analyses have been performed and to which safety controls identified by such analyses have been incorporated in the work permits and work procedures.

3.3.1.4 Opportunities for Codifying Current Good Practices

CHALLENGE: While statistics indicate that the overall worker protection record of DOE's contractors has been quite good, there are always opportunities for improvement and for ensuring continued good performance in the future. The experience of DOE with the Enhanced Work Planning initiative clearly shows a need for some improvement, as does the rash of worker injuries sustained this past year.

A major target of opportunity for improvement with respect to worker radiation safety is the tightening of measures to keep exposures ALARA. The administrative and operational goals

Authorization Protocols

	INTEGRATED SAFETY CONTROL SET*			
	Safety Sector	**Hazards Assessment**	**Hazards Controls**	**Authorization Protocol**
Macro Level	Public	SAR and Graded Equivalents DOE Orders 5480.23	Technical Safety Requirements: • Design (Engineered Controls)	• Authorization Agreement - High/Moderate Hazards Facilities Category 1 and 2
	Worker Sector A	Process hazards Analysis: 29 CFR 1910.119, Risk Management Program; 40 CFR 68	• Work practices and administrative procedures	• Authorizing Correspondence Moderate/Low Hazards Facilities Category 3 and 4
Micro Level	Worker Sector B	Job Hazards Analysis and Equivalents DOE Order 440.1 IG 440.1-1	Work Control Conditions: • Engineered Controls • Work practice and administrative procedures • Personnel Protective Equipment	• Rad Work Permits • Work Control Permits • Operation Procedure
	Environment	NEPA Documentation Permit Support Documents	Discharge Control: • Engineered features • Limits on discharges	Discharge Permits • air • water • solid wastes

* Safeguards and Security not included

Figure 10.

established by DOE target the annual exposure levels contractors are expected to use in planning their work, but DOE's expectations might be more sharply defined by the following:

- The design features and other control measures indicated by Process Hazards Analysis (SARs or equivalents and JHAs and equivalents) as needed to prevent radiation exposures from exceeding DOE's occupational annual exposure limit of 5 rem (10 CFR § 835.202) should be formalized as Occupational Safety Measures (OSMs). It should be made clear that the OSM's are to prevent both routine and accidental overexposure. Such OSMs should be subject to the same DOE review to determine adequacy, and the same subsequent oversight as are required for Technical Safety Requirements (TSRs) to ensure public protection, though the quality assurance (QA) measures for engineered systems which are OSMs may not merit the same stringency as corresponding TSRs.

- In keeping with the ALARA principle, the Job Hazard Analyses performed for work planning of nonroutine, short-term jobs, in particular, should consider the potential for mishaps that might cause needless exposures. The Work Control Permits and Implementing Procedures should identify the controls needed to keep exposures within the targeted annual operational ranges shown in Figure 9. In effect, worker protection measures should reasonably ensure that neither normal operating conditions nor reasonably foreseeable mishaps would cause a worker to experience exposures on any one job that would approach the 5 rem annual limit or any substantial portion thereof.

- Integrated Safety Management programs of DOE contractors should identify those manuals of practice to be used and/or should provide other evidence of a commitment to effective work planning for worker protection. Methodologies for performing hazard analysis and identifying appropriate worker protection measures such as those identified by the Center for Chemical Process Safety (1992) should be embodied in contractors' work planning practices.

- Contractors should be expected to develop operational procedures that embody the design and control measures identified through their hazard analysis, and to instruct workers as appropriate in the use of such procedures.

- The performance measures built into contracts as a basis for fee awards should include a record of prevention of fatalities and serious injuries and loss of work time from accidents that is comparable to or better than is experienced in the best of related industries.

- DOE's initiatives for improving work planning should include the continuation of a forum for the exchange of experiences in safety-related activities among DOE contractors and the enrichment of their programs.

Establishment of these improvements would be consistent with the concept of safety management advocated in DNFSB/TECH-5 and DNFSB/TECH-6, and with the Board's Recommendation 95-2. They would also be consistent, in the Board's view, with the concepts set forth in 29 CFR § 1910.119.

3.3.2 PUBLIC PROTECTION

3.3.2.1 The SAR and SAR Equivalents

DOE's guidance for public protection programs to be established by contractors are set forth in DOE Orders 5480.22, *Technical Safety Requirements*, and 5480.23, *Nuclear Safety Analysis Reports*. Such DOE Orders become applicable when they are invoked by contract terms. Several Key requirements of these Orders are particularly pertinent to the present discussion. Specifically, the contractor operating facility shall:

- Perform a safety analysis that develops and evaluates the adequacy of the safety basis for each nuclear facility. The safety basis to be analyzed includes management, design, construction, and engineering characteristics necessary to protect the public, workers, and the environment from the safety and health hazards posed by the nuclear facility or non-facility nuclear operations.

- Adhere to the assumptions and commitments set forth in the safety analysis.

- Issue TSRs that define the conditions, region of safe operating parameters and management or administrative controls necessary to ensure safe operation of the nuclear facility and to reduce the potential risk to the public and facility workers from uncontrolled releases of radioactive materials or from radiation exposure due to inadvertent criticality.

DOE's radiological protection practices for developing controls for high-hazard facilities and operations are reasonably well established. The emphasis on the concept of "defense in depth" is not as well embedded in the Orders, guides, and standards that DOE has issued but DOE's requirements with respect to SARs for new high-hazards facilities (Categories 1 and 2) are, in general, comparable to what is done in the commercial industry. However, there are few facilities or operations to which the SAR requirements in DOE Orders and associated guidelines apply completely. Many DOE facilities have aged and have considerably different missions than in years past. Operations conducted in most do not present the same hazard potential as did earlier missions. Mission changes have occurred more rapidly than the SAR updates. The result is that many DOE facilities still classed as operational, though near the end of their operational lives, and most of those being readied for deactivation and decommissioning, are not current with respect to the identification of hazards and appropriate controls. DOE has allowed its contractors to grade facilities by hazard category and to grade the comprehensiveness of safety assessments according to hazard potential and operational future. The result is a program that includes some SAR upgrades, but one using “SAR equivalents” to define controls as a basis for continued operation of old facilities and for limited operations within them during materials stabilization and cleanup.

SARs or “SAR equivalents” tailored to the hazards of particular facilities/operations are prerequisites to the establishment of controls for protection of the public and workers. The Board, in collaboration with DOE, has identified ten facilities as priority targets for establishing Integrated Safety Management programs. DOE is also developing a listing of other DOE facilities that will be the focus of follow-on actions to make such a program encompass all major facilities that fall under the provisions of the Atomic Energy Act.

3.3.2.2 Acceptable Level of Safety

> ***CHALLENGE: DOE needs to establish an evaluation guideline—uniform reference values of radiation dose—to be used by contractors in assessing the adequacy of engineered design safety features provided to protect the public from the consequences of potential accidents. One measure of adequacy should be the extent to which defense in depth is provided by engineered design features against potential accidental events.***

DOE has made a number of attempts over the past several years to establish such an evaluation guideline (e.g., draft standard DOE-STD-3005). For a number of reasons, consensus was not achieved and the draft standard was abandoned. Lacking official guidance, contractors, apparently with local DOE acceptance, have established their own limiting values of radiation effects from accidents. Consequently, more than a dozen different sets of evaluation guidelines are in use among the defense nuclear facilities.

The way such guideline values are used is just as important as the reference values themselves. It is particularly important that such guideline values not be treated as doses “allowable” to members of the public. They are intended only as a frame of reference against which to assess the adequacy of the engineered safety measures that are provided to prevent or mitigate accidental releases of radioactive materials into the public domain.

DOE’s SAR guidance encourages attention to “dominant accident” scenarios as opposed to a spectrum of scenarios. Further, safety analysts are encouraged to focus on engineered systems and associated controls only when calculated consequences exceed evaluation guidelines. The result is engineered designs targeted at bounding conditions, rather than a range of conditions to achieve defense in depth.

One of the frames of reference the Board uses in evaluating the adequacy of DOE standards is the practice of the commercial sector. For facilities other than reactors, NRC uses an evaluation guideline value of 5 rem total effective dose equivalent (TEDE) to a member of the public (10 CFR 72, 10 CFR 70) as a reference value for maximum exposures under accident conditions. DOE would be well advised to have contractors use the same reference value uniformly.

3.3.2.3 Some Important Remarks on Implementation

CHALLENGE: The complex-wide implementation of Integrated Safety Management of hazardous activities will be paced by the preparation, review, and acceptance of contractors' Integrated Safety Management program descriptions, the updating and review of the "authorization bases" for such activities, and the establishment of authorization agreements for high-hazard facilities.

It is not realistic to man every field office with all the expertise needed to exercise its responsibilities. DOE has recognized the need to identify a complex-wide core group that the field offices can draw upon for support when required to review contractor submittals and advise the approving authority. The protocols for deploying such resources need to be developed and tried in establishing the Integrated Safety Management programs for the ten priority facilities, and the lessons learned used in institutionalizing the process. A similar discovery was made during the regularizing of Readiness Reviews over the past few years. In fact, the same core group used for the Readiness Reviews could assist in the process of DOE's review and approval of contractor Integrated Safety Management plans.

The tailoring of controls for some facilities will require difficult decisions with respect to backfits. This will be particularly so for those aspects of facility designs which may not meet current standards of practice in the containment of hazardous materials during credible, yet unlikely, disruption by fires or seismic events. Guidance on the grading process could be useful, but is not likely to be a recipe that will fit all situations. The test of reasonableness will have to be based on factors unique to the situation.

Although there appears to be a renewed commitment to integration of safety planning and work planning, it remains to be seen how far this commitment extends. As discussed earlier, the separation of engineering design and safety assessment has been quite common throughout the DOE complex. The preparation of SARs has become a speciality that is too often assigned to the specialists after the fact. The specialists are expected to show adequacy of a design, rather than to explore establishing safety through design. Safety analysis and design must once again be closely linked as iterative processes if safety through design is to be achieved. This need applies whether the facility is in the preconstruction planning phase or facing upgrades for a changed mission.

3.3.2.4 Who Controls What?

CHALLENGE: There needs to be a clearer demarcation between safety controls over which DOE wishes to retain close control and those relegated to control by the contractor, subject to periodic assessments and local surveillance by DOE (e.g., by Facility Representatives).

At times, DOE has been criticized for micro-management of its contractors, while at other times it has been charged with insufficient oversight and safety management. The Integrated Safety Management concept stresses the establishment of clear expectations on the part of DOE in the form of mutually agreed upon oversight and control measures. Figure 10 illustrates one method of rational safety oversight. Under such an oversight concept, DOE would retain responsibility for safety overall, with control measures (macro) for protection of the public and protection of workers from serious injuries or exposures being tightly controlled by DOE, and (micro) control measures aimed largely at occupational safety being developed and controlled as a primary responsibility of the contractor. For the latter, the contractors' work planning/safety planning manuals of practice would be subject to DOE review for compliance with the OSH Act. Planning products, such as Work Permits, would be subject to spot reviews by DOE's local workforce.

DOE needs to establish an enforcement pattern that differentiates findings on noncompliance. There is evidence of contractor reluctance to establish control measures in the form of TSR's. Loosely structured administrative control measures are commonly preferred to Design Controls, with associated Limiting Condition of Operations (LCOs) or Operating Limits (OLs). This resistance to structuring robust and enforceable safety management control measures stems in part from the natural desire to avoid sanctions from enforcement actions, particularly those under provisions of the Price-Anderson Amendment Act.

3.3.3 ENVIRONMENTAL PROTECTION

Controls developed in the interest of protecting workers and the public from radiation are also valuable for protecting the environment. Controls for preventing and mitigating normal operating releases, and large accidental releases of radioactive material are defined through planning for normal condition and accident analyses in SARs or SAR equivalents. Environmental documents required by NEPA (e.g., Environmental Assessments/Environmental Impact Statements [EISs]) are dealt with separately. These also address the effect of releases of radioactivity, and in some cases dictate the incorporation of additional controls. These analyses are not entirely independent and their preparation should be integrated to ensure consistency of assumptions, design considerations, and other controls.

EPA and state permitting processes must be satisfied in anticipated normal discharges of radioactive material to water or air, and in disposal of solid radioactive wastes mixed with other controlled wastes. Although DOE is ultimately responsible for environmental protection measures, it looks to its operating contractors to obtain the requisite permits for discharges (air, water, and solid wastes) as required by EPA and the states.

CHALLENGE: Although the materials and processes that present a potential for radiological hazards to the public and workers are the same as those that might threaten the environment, they are most often treated as though they are not. Controls are often identified by separate analytical processes and administered by different organizational units. The challenge is to eliminate as

much as possible the duplication and overlap of analysis and to develop a closer coupling of design and environmental impact analyses.

The development of Environmental Impact Statements has become essentially a cottage industry. More so even than with the SARs, the forced separation of the analysis of the potential environmental impacts from the engineering of the work has made the report a product unto itself rather than a tool or forcing function for achieving more environmentally sound design solutions.

The historical basis for developing SARs and EISs as if they were totally disconnected needs to be revisited. The division was established by AEC before regulation of the commercial use of atomic energy was turned over to NRC. AEC elected to require separate reports for satisfying Atomic Energy Act and NEPA requirements. NEPA documents were subject to reviews by other federal agencies having expertise in the issues and subject matter covered by the documents, and the agency taking the proposed action was required to consult with these other agencies before proceeding. This was not so with documents submitted to AEC under the Atomic Energy Act. The original basis for having separate environmental reports required under NEPA and the SARs under Atomic Energy Act was largely the result of a preference for cleaner separation of regulatory jurisdictions. Jurisdictional overlaps often cause inefficiencies in administration.

DOE currently maintains an interface of a similar nature in the program of the Office of Environmental Management (EM) for transitioning facilities from operational status to deactivation and eventual dismantlement or reuse. The characterization of hazards from residuals in facilities slated for deactivation and decommissioning and the establishment of controls needed to maintain safety in the interim must take into account DOE’s responsibilities under the Atomic Energy Act. However, they must also be compatible with the subsequent transition to regulation by EPA and the states of the final disposition of the facilities under CERCLA and the Resource Conservation and Recovery Act (RCRA) (e.g., Decommissioning of the Plutonium Concentration Facility, 233-S, at Hanford).

3.4 INTEGRATION BY MEDIA/HAZARDS: NUCLEAR AND NON-NUCLEAR

While the dominant safety issue with respect to facilities producing or using radioactive materials may well be radiological, DOE’s research and industrial complex also includes operations with hazards and hazardous materials that are not radiological. Yet the historical emphasis on radiological safety still exists. Further, the media orientation of our national environmental protection programs have contributed to a “stovepiping” rather than an integrated approach to the development and implementation of hazard controls.

The effect of this approach is most evident in the review and establishment of protective measures to be applied at the workplace, i.e., worker protection. In accordance with 10 CFR Part 835, it is common practice for contractors to issue Radiation Work Permits (RWPs) as a part of planning for performance of tasks such as maintenance, and to use an entirely different Work Control development process and Work Control Permit to specify controls for the hazardous aspects of the same task that are nonradiological. In principle, there is no logical reason why work planning at the task (e.g., contaminated component replacement) and activity (e.g., radioactive material stabilization, tank draining) levels cannot be done as an integral process, with radiological and nonradiological hazards considered simultaneously. DOE has had a pilot program under way for some time on Enhanced Work Planning at the task/activity level that has demonstrated definite advantages to such a method.

> ***CHALLENGE: The hazard assessment/control development process could well be executed in a much more integrated way. Workers performing tasks involving multiple hazards, including those associated with radiation, are frequently required to interpret and integrate the conditions of permits generated independently by different groups. In effect, the Work Control Permit as currently developed can be a stack of permits stapled together. DOE's contractors should be challenged to integrate their work planning processes, particularly at the task level, to provide the first line manager with a single set of work instructions including controls arising from consideration of all hazard as an integrated whole.***

4. TAILORING CONTROL MEASURES TO HAZARDS

The basic framework for ensuring protection of the public, workers, and the environment as set forth in DOE rules and safety Orders requires adaptation to the specifics of the work performed. As described in previous sections of this report, work is planned to be performed at the facility, activity, and task levels. That work can be done on either a routine basis, such as production of specific products, or a nonroutine basis, such as replacement of equipment, stabilization of special material, and remedial actions. The tailoring of safety control measures to the specifics of the work and the hazards involved is an important feature built into the Integrated Safety Management concept. As the word tailoring implies, the concept emphasizes the need to fit the safety measures to the specifics of the work. This is an intellectual engineering exercise, not a preconfigured one-size-fits-all method.

One of the commitments in response to the Implementation Plan for Recommendation 95-2 is the development of guidance on tailoring. This is a worthwhile endeavor in which the Board and the Board's staff have been discussing with counterparts in DOE. The following thoughts are offered in the interest of furthering the dialogue.

Guidance on tailoring might well be structured according to the safety functions that are mutually agreed by DOE and the Board to be basic:

- Identify Applicable Requirement and Guides/Site Wide,
- Define Work,
- Analyze Hazards,
- Develop and Implement Controls,
- Perform Work,
- Assess, Feedback, and Improve.

This listing does not correspond exactly to the five-function diagram shown earlier in Figure 1, taken from the 95-2 Implementation Plan. Figure 1 indicates that the identification of applicable requirements is done as part of the development of controls. Indeed, this may be so at some sites in the near term. However, if identification of applicable requirements and subtier technical standards is done at that stage of work planning, it should be done generally as a fine-tuning exercise. The above listing is intended to emphasize the expectation that in keeping with Recommendation 95-2, all DOE contractors responsible for safe conduct of hazardous work at defense nuclear sites will have in place a base set of requirements and associated implementing procedures (mechanisms per policy statement P450.4) that will be generally applicable to all work planning/safety planning done on site (see Figure 3).

4.1 IDENTIFYING APPLICABLE REQUIREMENTS

The Board has given much attention to the requirements and associated guidance established by DOE as the framework for safety management of its hazardous activities. The

Board has supported the development of requirements and guidance documents that represent best practices as accepted widely in safety circles. However, because the DOE mission covers so many different types of activities, representing different hazard levels, DOE requirements set forth in regulations and safety Orders cover more situations than may be pertinent to work in any one place or to any one activity. The Board has exerted pressure for contractors to comply with requirements imposed by DOE through either rules or contract terms, but only to the extent that these requirements are applicable to the specifics of the hazardous work to be done. The determination of applicable requirements is an important prerequisite for the tailoring concept built into Integrated Safety Management. Once requirements have been identified, methods of compliance can then be tailored to suit the hazards of specific activities.

This paper describes a process that is based on the site contractor's establishment of mechanisms or infrastructure for implementing requirements in DOE rules and safety Orders that DOE and the contractor mutually agree are applicable to the planning and performance of missions assigned to the contractor. Some contractors have labeled this infrastructure as their "Essential Standards" program. These standards are to serve as a basic framework that it is incumbent on all managers of specific activities on site to use in planning work. The specific control measures resulting from these planning exercises, augmented by industry consensus standards, if appropriate, and adapted to the specifics of the hazards, are then to become the conditions, or "safety envelope," within which the work is to be performed. This concept of a requirements-based infrastructure is the ideal towards which DOE is striving for long-term operational missions that include the design, construction, operation, and decommissioning of nuclear facilities, such as those at Los Alamos, Pantex, and Savannah River. The infrastructure for sites whose mission is predominately decommissioning and cleanup, such as Hanford and Rocky Flats, justifiably could be considerably different from this ideal. Infrastructure appropriate for the latter could be expected to be skewed much more to the planning needs for cleanout of formerly used production facilities and environmental restoration of the sites.

4.2 DEFINING WORK

Congress has assigned DOE a variety of missions. The work required to satisfy these mission objectives must be broken down into discrete units or packages whereby it can be planned and performed. Tailoring in the context of defining work is the establishment of such a work breakdown. There is no unique way to break down the structure of work. The breakdown may well be different for different purposes—accounting versus technical management, for example. However, from the standpoint of integration of work planning and safety planning, whatever is mutually agreeable to DOE and its contractors must be clearly discernible and amenable to the structuring of safety envelopes within which the work is to be performed.

In general, the work assigned by DOE to its contractor is performed at the facility, activity, and task levels. Hence, safety controls should be developed for work performed at these levels.

Figure 13 illustrates a partial work breakdown structure for work at Pantex based on the Stockpile Management and Stewardship mission of DOE's defense programs. The work illustrated is the dismantlement of several specific weapon systems. Safety management of that work will require safety control measures specific to the hazards of dismantlement, using the bays and cells designated for such operations. Such control measures must include those that are specific to the activity (i.e., each weapon system), as well as to the facility.

4.3 ANALYZING HAZARDS/DEVELOPING AND IMPLEMENTING CONTROLS

A variety of processes for analyzing hazards at the facility, activity, and job task levels were summarized in Figures 10 and 11. Further guidance is needed as to when different types of analyses are appropriate (e.g., when a SAR is required and when a BIO may suffice). If such guidance is to be established on a per case basis, that needs to be stated. These hazard analyses, whether at the facility, activity, or job task level, are crucial to the safety planning process. It is absolutely essential for DOE to make clear that such analyses and the safety measures identified thereby are central to the case the contractor must make to DOE to receive authorization to perform the work. As discussed under the Worker Protection section 3.3.1, clearer demarcation is needed between safety controls DOE wishes to approve and those DOE delegates to the contractor to develop and implement, with oversight of performance by DOE.

Tailoring of controls to the specifics of the hazards is not a completely new practice. However, as indicated earlier, this tailoring has not been accomplished consistently or equally well across the complex. When done well, such tailoring of controls is accomplished along the lines illustrated in Figure 11. In effect, as the potential for harm increases, the safety assurance measures increase in number and intensity. For the diversity of activities DOE contractors must perform, it is not feasible to define precisely what measures would make an operation safe enough. This inevitably becomes a judgment call. To make such a system work requires planners with expertise in the hazardous materials and processes involved and the practices that are commonly used to ensure the safety of the public, workers, and the environment. It also requires that officials who do the reviewing have the requisite experience and fortitude to decide how safe is safe enough.

4.4 PERFORMING WORK

Considerable progress has been made toward defining and implementing tailoring in the performance of Operational Readiness Reviews, in response to the Board's Recommendation 92-6 and several earlier recommendations. The requirements are defined in DOE Order 425.1, *Startup and Restart of Nuclear Facilities*. The Board has also just recently released DNFSB/TECH-15, which discusses good practices in the conduct of operations. That guide discusses the embodiment of controls in procedures and the training of personnel in those procedures in the interest of achieving in the workplace the safety goals sought through the planning process. While the formality of operations discussed in DNFSB/TECH-15 is most

Integrated Safety Control Set							
Safety Sectors	Engineered Design Features[1]		Admin. Controls[2]	Work Practice[3]	Personal Protective Equipment	Skill of the Trade	
Public							Red
Worker (High Risk Task)							Pink
Worker (Moderate Risk Task)							Yellow
Worker (Low Risk Task)							
Environment							
Facility							

[1]Engineered Design Features are equipment, systems, structures and components identified in the hazards analysis as needed to prevent or mitigate the hazards. Those in zones red and pink are subject to more stringent quality assurance provisions than those in zone yellow.

[2]Administrative controls consist of those controls identified in the TSRs and any other controls administered by the contractor; including two-man rule, work schedule, and man power restrictions to reduce the operational risk.

[3]Work practice controls alter the manner is which a task is performed. Some examples of work practice controls include: Procedural controls to incorporate steps for worker protection, mockup training, incorporation of good radiological work practices.

Figure 11.

applicable to the high-hazard range of operations, the practices lend themselves to tailoring as a function of the potential for harm (Figure 12).

4.5 FEEDBACK AND IMPROVEMENT

Hazardous work at defense nuclear facilities is subject to a variety of oversight and assessment activities by both DOE and its contractors. Assessments range from observations made daily by line managers as they perform their assignments, to yearly summary of statistics gathered through various reporting systems (e.g., *Occurrence Reporting*, DOE Order 232.1, *Safety and Health Reporting Requirements;* DOE Order 231.1, *Accident Investigations;* DOE Order 0225.1, *Performance Indicators;* and DOE 0210.1, *Management Assessment Requirements for Quality Assurance*).

In simplified terms, these data streams are like a medical scrutiny that is performed at different depths on a regularized basis—ranging from a daily exam that consists of asking how the patient feels (self-assessment) to an annual physical when extensive data are gathered to assess the general state of health and determine the presence or lack of degenerative conditions. The purpose, of course, is to have a factual basis for affirmation of fitness or to establish a correction plan, if needed to achieve a better state of fitness.

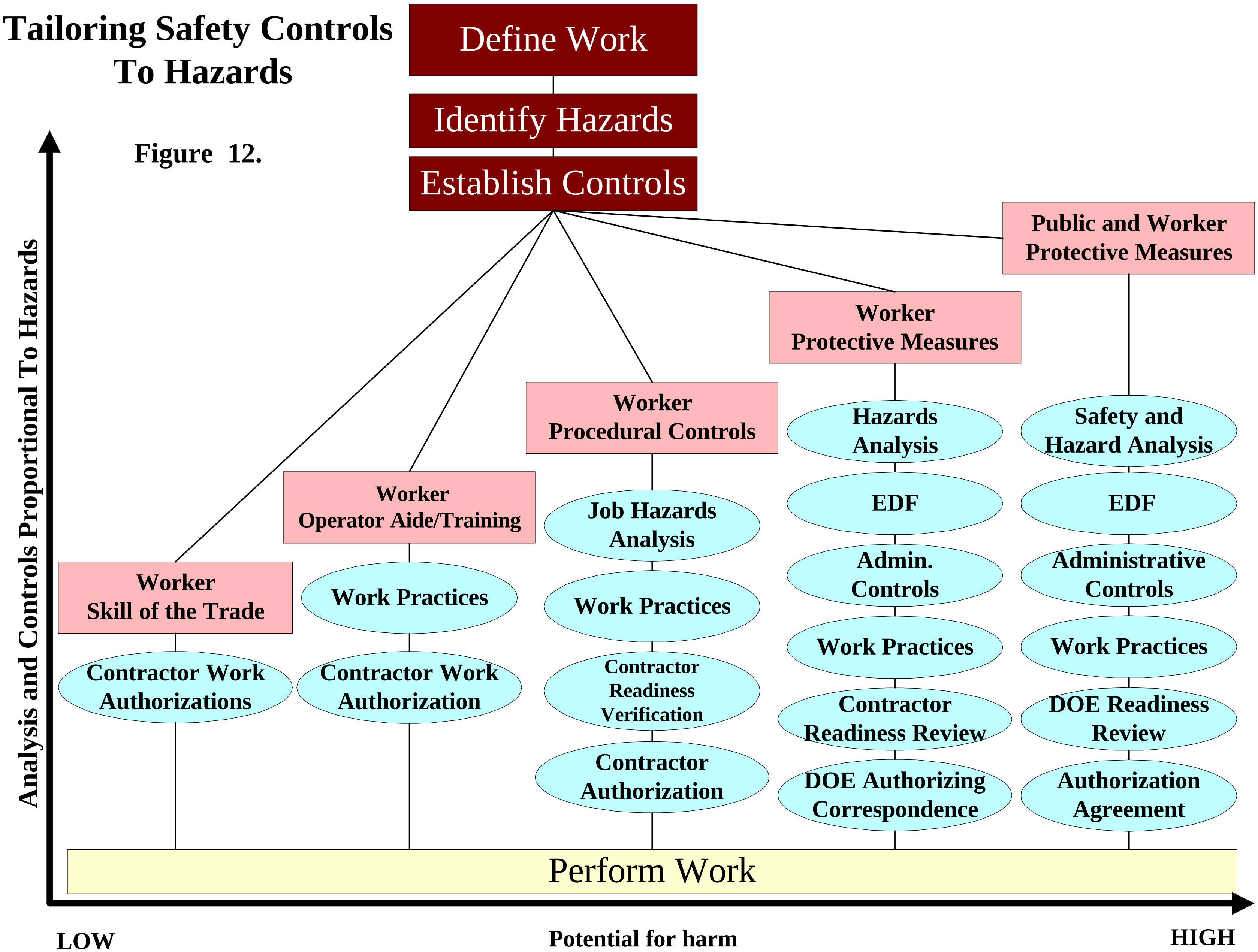
The gathering of data by DOE for safety purposes presumably has the same objective. However, there appears to be a disconnect between those who collect the data and those having responsibility for diagnosis, planning of corrective action, and its implementation. This matter merits attention in developing the *Functions, Responsibilities, and Authorities Manual.*

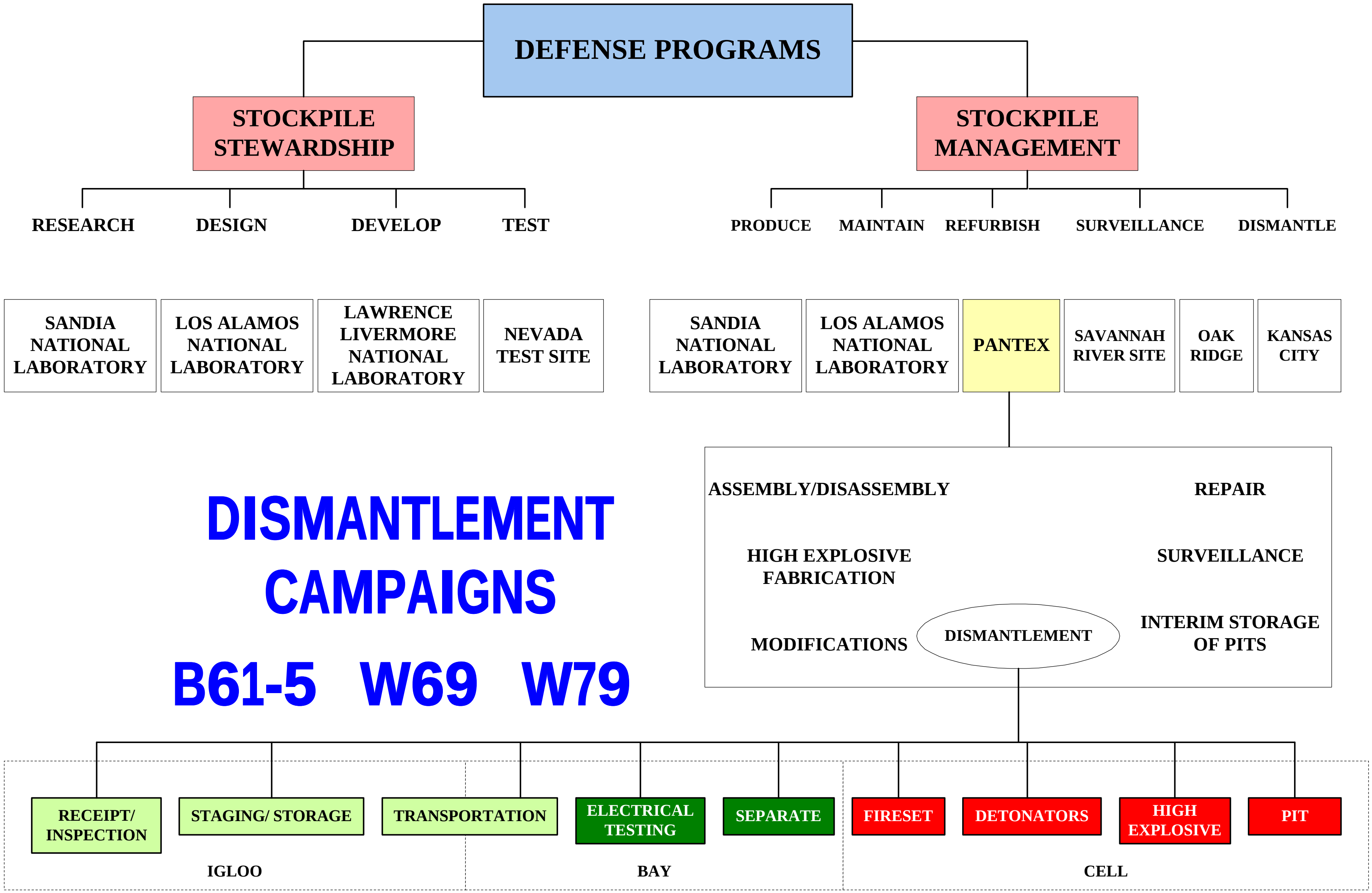
As noted earlier, DOE has been criticized for micro-managing its contractors, particularly the laboratories. This matter was one of the major criticisms made in the Galvin Report (Galvin, 1995) and more recently in a study performed by the Institute for Defense Analysis (1997). The DOE staff, in response, has drafted a proposed policy statement P450.5 that would make contractor self-assessment programs the cornerstone of DOE's oversight program. Several pilot self-assessment programs have been initiated. This initiative is an example of the concept of tailoring. In this case, DOE is exploring the degree of reliance to place on the contractor's appraisal of the "state-of-health" of its own safety management program. The pilot efforts have not matured sufficiently to allow that determination to be made as yet.

With respect to tailoring this function, in general the challenge is to develop enough assessment data to ensure that DOE's responsibilities for protection of the public, workers, and the environment, as delegated to its contractors, are being fulfilled without unduly intruding on or micro-managing work only the contractors can perform.

Tailoring Safety Controls To Hazards

Figure 12.





Breakdown Structure for Dismantlement at Pantex

FIGURE 13.

5. SUMMARY

The success of the endeavor to integrate into one effective safety management program the controls necessary to provide protection of the public, workers, and the environment will depend much upon our ability to agree on a common vision of what such a program should be and to make it a reality. The vision set forth in this paper is that of a system that will integrate work planning and safety planning, and that should be adaptable to planning at all levels, for all sectors, and for all hazards. The program is to be standards-based[2] with safety measures tailored to the hazards of the work to be done.

The acceptability of Integrated Safety Management programs will be highly dependent upon whether the mechanisms for achieving these objectives are in place and how well they are being implemented. A highly qualified workforce is essential for planning and doing work safely.

The overall challenge for DOE is to structure and implement a requirements base that will drive the managers of its programs toward the achievement of Integrated Safety Management. Articulation of objectives and principles is not sufficient. DOE must require its contractors to put in place a standards-based system for Integrated Safety Management that provides reasonable assurance that the work contracted will be performed safely.

Having established the basic framework for assuring safety, DOE as management/owner ultimately responsible for safe operations conducted by its contractors, must be satisfied through review and concurrence that a satisfactory structure has been developed on that framework, is being used as intended, and is effective in achieving the basic objective of DOING WORK SAFELY.

Neither DOE nor its contractors are beginning from ground zero in addressing the challenges posed in this paper. A requirements base that has been in existence for years has been used reasonably effectively by some contractors in establishing site-wide and activity-specific work protocols for performing missions. Others are not so well organized and disciplined. The diversity is largely a result of the lack until now of a corporate expression of common expectations and the wide latitude and independence given Field Offices in the management of their contractors. Virtually all existing safety management programs evidence the effects of development and implementation by parts. All can benefit from examining those programs for effectiveness as an integrated whole.

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[2] The term "standards" is used here in the broadest sense, encompassing all DOE safety-related directives or rules, Orders, DOE and industry technical standards, guides, manuals, and policy statements.

TABLE 1
SAVANNAH RIVER SITE SAFETY MANAGEMENT SYSTEM MATRIX
Guiding Principles to Safety Function

Safety Functions	Line Management Responsibility for Safety	Clear Roles and Responsibilities	Competence Commensurate with Responsibilities	Balanced Priorities	Identification of Safety Standards and Requirements	Hazard Controls Tailored to Work Being Performed	Operations Authorization
Define Scope of Work	WSRC-6B	WSRC-6B	WSRC-4B WSRC-5B	WSRC-6B	WSRC-8B	WSRC-6B WSRC-1-01 MP6.11,6.13 WSRC-8B WSRC-11Q	WSRC-6B
Analyze Hazards	WSRC-11Q WSRC-E7 WSRC-1E6	WSRC-11Q WSRC-E7 WSRC-1E6	WSRC-4B WSRC-5B	WSRC-11Q WSRC-E7 WSRC-1E6	WSRC-8B WSRC-E7	WSRC-8B WSRC-11Q WSRC-2S WSRC-E7 WSRC-1E6	WSRC-12Q
Develop/Implement Controls	WSRC-6B WSRC-1B MRP3.01 WSRC-E7 WSRC-1E6	WSRC-8B WSRC-1B MRP3.01 WSRC-E7 WSRC-1E6	WSRC-6B	WSRC-8B WSRC-E7 WSRC-1E6	WSRC-8B WSRC-E7 WSRC-1E6	WSRC-8B WSRC-11Q WSRC-2S WSRC-E7 WSRC-1E6	WSRC-12Q
Perform Work	WSRC-2S WSRC-1Y WSRC-1E6	WSRC-2S WSRC-1Y WSRC-1E6	WSRC-2S WSRC-1Y WSRC-1E6	WSRC-2S WSRC-1Y WSRC-1E6	WSRC-2S WSRC-1Y WSRC-1E6	WSRC-12Q WSRC-2S WSRC-1Y	WSRC-12Q WSRC-2S WSRC-1Y
Feedback/Improvement	WSRC-8B WSRC-9B WSRC-12Q	WSRC-8B WSRC-9B WSRC-12Q	WSRC-8B WSRC-9B WSRC-12Q	WSRC-12Q	WSRC-8B WSRC-12Q	WSRC-12Q	WSRC-12Q

TABLE 2

SAVANNAH RIVER SITE SAFETY MANAGEMENT MECHANISMS REFERENCE LIST

WSRC Manuals and Policies:

WSRC 1-01	*Management Policies*
WSRC-1B	*Integrated Procedure Management System*
WSRC-4B	*Training and Qualification Manual*
WSRC-5B	*HR Policies, Practices, and Procedures*
WSRC-6B	*Program Management Manual*
WSRC-8B	*Compliance Assurance Manual*
WSRC-9B	*Site Item Reportability and Issue Management*
WSRC-2Q	*Fire Protection Program*
WSRC-3Q	*Environmental Compliance Manual*
WSRC-4Q	*Industrial Hygiene Manual*
WSRC-5Q	*Radiological Control Manual*
WSRC-6Q	*Emergency Management Program Procedure Manual*
WSRC-11Q	*Facility Safety Document Manual*
WSRC-12Q	*Assessment Manual*
WSRC-14Q	*Material Control and Accountability*
WSRC-19Q	*Transportation Safety*
WSRC-20Q	*Health and Safety for Hazardous Waste Operations*
WSRC-1S	*SRS Waste Acceptance Criteria Manual*
WSRC-2S	*Conduct of Operations Manual*
WSRC-1Y	*Conduct of Maintenance Manual*
WSRC-E7	*Conduct of Engineering and Technical Support Procedure Manual*
WSRC-1E6	*Construction Management Department Manual*
WSRC SCD-3	*Criticality Safety Manual*
WSRC 1M-90-135	*SRS Process Safety Management Manual*
MRP 3.01	*Integrated Procedure Management System*
MP 6.11	*Facility Management Council and Executive Committee*
MP 6.13	*Regulatory Compliance Council*

TABLE 3

LLNL SAFETY ENVELOPE
Building 332

<u>LLNL's Health and Safety Manual</u>

Chapter 1: LLNL ES&H Policies and Responsibilities, Nov. 96

Chapter 2: Integrating ES&H into Laboratory Activities, Sep. 94

Supplement 2.02: Preparation of Operational Safety Procedures and Facility Safety Procedures
Supplement 2.10: Guidelines for the Shutdown or Transfer of Operations or Buildings, Oct. 96
Supplement 2.19 Conduct of Operations for LLNL Facilities, Nov. 92
Supplement 2.20: Personnel Selection, Qualification, Training, and Staffing at LLNL Nuclear Facilities, Nov. 96
Supplement 2.21 Implementation Guide for the Unreviewed Safety Question Process, Sep. 94
Supplement 2.30: Guidelines for Decontamination and Disposition of Radioactively Contaminated Facilities and Associated Equipment, Mar. 94
Supplement 2.31: Startup and Restart of Nuclear Facilities, Nov. 96

Chapter 3: Emergency Management, Jan. 97

Chapter 4: Incidents-Notification, Analysis, and Reporting, Feb. 96

Chapter 6: Design and Construction, Jul. 90

Supplement 6.06: Safety Analysis Guide, Sep. 88

Chapter 8: Hazardous Material Control, Nov. 95

Chapter 10: Personal Protective Equipment, Aug. 91

Chapter 11: Access Control, Safety Signs, and Alarm Systems, Jul. 90

Supplement 11.07: Personnel Safety Interlocks, Aug. 89

Chapter 12: Ventilation, May 91

Supplement 12.01: Evaluation and Control of Facility Airborne Effluents, Feb. 89
Supplement 12.03: Work Enclosures for Toxic and Radioactive Materials, Aug. 91
Supplement 12.05: High-Efficiency Particulate Air (HEPA) Filter System Design Guidelines for LLNL Applications, Aug. 91

Chapter 34: Sanitation, Oct. 89

Chapter 35: Vehicle Operations and Traffic, Jan. 97

Environmental Compliance Manual, Jun. 96

Guidelines for Soil and Debris Management

Guidelines for Permitting of Air Emission Sources

Guidelines for Polychlorinated Biphenyls

Guidelines for Preparing Office and Shop Supplies for Disposal

LLNL Radiological Control Manual, 1993

Nuclear Material Controls and Accountability Manual, (Vol. 1 to 7), 1990

Onsite Hazardous Materials Packaging and Transportation Safety Manual, Feb. 96

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APPENDIX A: GLOSSARY OF TERMS

Understanding the terminology of safety management is essential. To that end, the following definitions are provided. Those terms marked by an * are explained more fully in DNFSB/TECH-5 (Defense Nuclear Facilities Safety Board, May 31, 1995). They are included in this document to make it self-contained.

*__Safety Standards:__ *Documented measures for the safe performance of work. Standards may be expressed in at least two ways: (1) criteria for measuring whether a condition indicative of safety has been met; and (2) prescriptions for how a certain safe result is to be achieved, including specified methods, procedures, materials, and actions. Safety standards are not necessarily requirements.*

This definition acknowledges that the term "standards" can be used in two ways. First, a standard can be a criterion for measuring whether a certain status or condition has been achieved; the standard states *what* is to be achieved. These standards are sometimes called "substantive" or "outcome" standards, and are often expressed as measurable limits. As an example, radiation protection standards have been characterized in these terms: "standards mean limits on radiation exposures or levels, or concentrations or quantities of radioactive material, in the general environment outside the boundaries of locations under the control of persons processing or using radioactive material." *(Reorganization Plan No. 3 of 1970, 5 U.S.C. Appendix I).* Standards of this type are often found in statutes and agency regulations.

The second type of standard is a prescription for achieving a certain status or condition. A standard of this type may specify methods, materials, procedures, and actions for *how* a certain result is to be achieved. These types of standards are often called procedural, but may also address *what* is to be achieved. Such standards are frequently developed by technical specialists, first as guidance, often using a consensus process. The National Fire Protection Association codes are examples of consensus standards developed by technical experts. The *Radiological Protection Control Manual* issued by DOE and NRC Regulatory Guides are examples of procedural standards issued by the government.

*__Safety Requirements:__ *Enforceable mandates governing public health and safety.*

The Atomic Energy Act and the Board's enabling statute anticipate that certain safety standards will be made legal requirements, ultimately enforceable in court. A general definition of a requirement that is well suited to the Atomic Energy Act and the Board's enabling statute is "an enforceable mandate governing public health and safety." Broadly, a requirement is a mandate that can ultimately be enforced by a court or other authority having jurisdiction, and that the person or entity subject to the mandate is bound under law to obey. One of the most important features distinguishing a safety standard that is a requirement from a safety standard that is not is that the former is fully enforceable against an organization or individual in noncompliance. See the definition of "enforcement" below. Most requirements are also enforceable, without resort to courts, through other administrative or contractual mechanisms. For example, it is expected that DOE would administratively enforce DOE regulatory and contractual requirements in the first instance. Requirements can be subdivided into the following categories based on their sources and their interpretation in law.

- **Statutory Requirements—**Statutes, both state and federal, specify certain health, safety, and environmental standards, and mandate compliance by individuals, government bodies, and corporations. Statutory requirements can be enforced by empowered state and federal officials using legal sanctions such as administrative orders and fines. These sanctions, if resisted, can ultimately be enforced by the courts. Moreover, enforcement officials may seek to enforce against statutory noncompliance by going to court in the first instance.

- **Judicially Imposed Requirements**—Federal and state courts can issue Orders in the form of injunctions or other mandates that certain actions be taken (or desisted from) by individuals, government bodies, and corporations, to adequately protect public health and safety. Court orders and other mandates can be grounded in statutes, regulations, or contracts, or can be based on principles of common law and equity. Tri-Party Agreements under the Comprehensive Environmental Response, Compensation, and Liability Act, endorsed by federal courts, are examples of such court-imposed safety, environmental, and health requirements. Safety standards incorporated into court orders would be legally enforceable requirements to the affected parties.

- **Regulatory Requirements**—Regulations are the products of rule making. The term is synonymous with the word "rule" when used in the formal sense described in the Administrative Procedure Act. Federal and state statutes have created agencies with the power to issue and enforce safety regulations, pursuant to statutes, which are designed to protect public health and safety. Regulations elaborate upon and expand the statutory safety requirements by using the agency's special expertise (usually scientific or technical) to promulgate detailed, generally applicable, regulations. Federal law dictates that safety requirements imposed by regulation must first be subjected to notice and comment from the regulated entity and the interested public. Safety standards imposed by regulations issued by such agencies have the force and effect of law and are enforceable against persons under the agency's authorized jurisdiction.

- **Order Requirements**—Federal and state agencies are also empowered to issue orders to specific persons or corporations to protect public health and safety. Orders, which carry certain procedural rights under the Administrative Procedure Act and parallel state statutes, can be of several types: (1) compliance orders, which demand that the ordered party comply with existing statutory and regulatory requirements; (2) penalty orders, which initiate an enforcement proceeding when a statutory or regulatory requirement has allegedly been violated; and (3) adjudicatory orders to a regulated entity, which are final agency actions in formal proceedings. All of these orders should be distinguished from typical DOE safety Orders, which are not legally enforceable until made a term of a contract, because they have not been promulgated according to the Administrative Procedure Act. Labeling something a DOE Safety Order does not make it an enforceable order requirement in the sense just described. "Order" as used by DOE in this context is a misnomer.

- **Contractual Requirements—**Two or more parties to a contract can impose on each other the obligation to take or desist from certain actions. Properly drafted contracts specify (1) the criteria by which performance by each party will be measured, and (2) the remedies that each party has in the event of nonperformance by the other. DOE safety Orders can be made mandatory and become contract terms when incorporated as such into contracts between DOE and its operating contractors. Contractual requirements are enforceable administratively under the terms and remedies provided in the contract, and ultimately in court.

- **Restrictions Imposed by Management—**Safety standards, such as technical procedures that are unilaterally adopted by Management and Operation (M&O) contractors can become "requirements" in a limited sense for the contractor's employees. Corporations and government bodies have the authority to reasonably direct the actions of their employees and sanction misconduct that threatens safe operations. This authority is circumscribed by constitutional constraints (e.g., discriminatory conduct) and statutory requirements (e.g., OSHA regulations). However, in the area of compliance with safety requirements, employers are typically given a great deal of latitude in specifying which procedures *must* be followed. These standards become fully enforceable by DOE against the contractor when they are promulgated in rules, agreed to as contract terms, or otherwise imposed as legal requirements. See arrow in Figure 4.

- **Exception or Exemption—**Relief granted by an agency (e.g., DOE) to an individual regulatee (contractor) from a requirement of general applicability after an administrative process assessing the need and justification.

- **Variance—**Relief granted from a contractual requirement.

Enforcement of Requirements: *Any action taken by an authorized entity to* remedy *or penalize (sanction) noncompliance with safety requirements; the ultimate goal of enforcement is to bring the entity violating the requirement back into compliance and to discourage noncompliance in the future.*

In most cases, DOE would initiate the enforcement action against the noncomplying contractor or its personnel. However, third parties with "standing" (some injury suffered as a result of the noncompliance) may also institute some forms of enforcement actions. Different levels of enforceability are associated with the forums that decide whether a noncompliance has occurred and what remedy is appropriate. Requirements based on contract terms can be enforced by either party. Thus, a contractor could enforce a contract against DOE.

- **Judicial Enforcement—**Federal and state courts can mandate by judicial order that the requirements in statutes, agency regulations, and contracts be carried out by persons, government bodies, and corporations. The specific instrument used by the court to remedy or to penalize noncompliance may be an injunction, a writ of mandamus, a decision upholding a fine or other administrative sanction, or in (criminal cases) conviction and sentencing of guilty parties.

- **Administrative Enforcement**—Federal and state regulatory agencies are granted enforcement powers that may include the power to issue compliance orders, impose fines and other civil penalties, and investigate and refer for prosecution potential criminal violations. See the definition of "Order Requirements" above under "Safety Requirements." Agency sanctions may ultimately be enforced by judicial order.

- **Contract Enforcement—**Parties to a complex contract normally specify a range of remedies for violations of contract terms. Contractual remedies may include mandatory compliance (specific performance), reduction of payments, mandatory procedures for resolving disputes such as arbitration, and in extreme cases, contract termination.

- **Managed Compliance**—Management officials of government bodies and corporations can impose internal policies and procedures upon employees by use of written standards of conduct, employment contracts, and internal directives. Sanctions to enforce compliance or punish violations range from informal reprimands to job termination.

Safety Envelope: *A collection of safety controls and other contractual or programmatic requirements agreed upon between DOE and contractors as necessary for safe performance of hazardous work, defined at the site, facility, activity, or task level.*

- **Safety Controls—**Consist of (1) active and passive engineered design features (structures, systems, and components and their support systems); (2) their associated safety, design, and operational limits; and (3) the administrative controls, safety programs, and work practices identified for protection of the public, workers, the environment, and the mission of the facility.

- **Authorization Basis**—Those aspects of the facility design basis and operational requirements relied upon by DOE to authorize operation. These aspects are considered to be important to the safety of facility operations. The authorization basis is described in such documents as the facility SAR and other safety analyses; the Hazards Classification Document, the TSRs, DOE safety evaluation reports, and facility-specific commitments made to comply with DOE Orders or policies.

- **Authorization Agreement—**A documented agreement between DOE and the contractor for high-hazard facilities (Category 1 and 2), incorporating the results of DOE's review of the contractor's proposed authorization basis for a defined scope of work. The authorization agreement contains key terms and conditions (controls and commitments) under which the contractor is authorized to perform the work. Any changes to these terms and conditions would require DOE approval.

- **Authorization Protocols—**This term is intended to encompass those processes DOE will use to communicate acceptance of the contractor's integrated plans for hazardous work. Such protocols are expected to range from preperformance review and approval by DOE of detailed safety-related terms and conditions for performing work (authorization agreement) to less rigorous oversight with postperformance assessment of the contractor's work.

- **Occupational Safety Measures—**Controls derived from a hazard evaluation or its equivalent hazard analysis that are relied upon to protect workers. Such controls are administered by the contractor and may or may not need DOE approval.

- **Operational Safety Controls**—Safety limits, operating limits, surveillance requirements, safety boundaries, and management and administrative controls that significantly contribute to protecting workers, the public, and the environment from hazards other than nuclear detonation, high-explosive detonation and deflagration, and fire (which are addressed by nuclear explosive safety rules), for specific nuclear explosive operations and associated activities.

- **Safety Programs**—Those programs identified in the authorization basis which require contractor adherence for safe operation of the activity. Such programs are determined from the hazard and accident analyses and are implemented through site/facility manuals or codes of practice.

- **Rules or Regulations**—In common parlance, these terms are synonymous. They refer to any set of administrative or substantive requirements and their attendant definitions, explanatory provisions, scoping statements, and interpretations that are lawfully promulgated for general applicability by an agency pursuant to the Administrative Procedure Act and a statutory granting of authority. (Not all, or even a majority, of provisions contained in DOE rules are in fact requirements that must be obeyed. Many provisions are definitions or other explanatory material.)

- **Technical Safety Requirements—**The requirements applicable to active and passive engineered design features and administrative controls that are required as a result of safety and hazard analysis for protection of the health and safety of the public and to minimize the potential risk to workers from significant hazards:

–Active Engineered Design Features—The set of safety-related systems, components, their support systems, and process parameters required for safe operation of the facility or activity. The TSRs should contain the following requirements applicable to these active controls.

- Safety Limits
- Operating Limits
  - Limiting Control Setting
  - Limiting Conditions for Operation
- Surveillance Requirements

–Passive Engineered Design Features—The set of safety-related passive design features which if altered or modified would have a significant effect on safe operation of the facility or activity. The TSRs should contain the following information on these features:

- Safety Limits
- Design parameters and Operating Limits important to safety
- Surveillance Requirements

–Administrative Controls—The set of requirements applicable to the organization, management, and performance of activities necessary to control the significant hazards. The Administrative Controls typically consists of the following categories:

- contractor responsibility and organization
- operating support
- safety programs
- integration and management infrastructure

APPENDIX B: LIST OF ACRONYMS AND ABBREVIATIONS

AEA	Atomic Energy Act
AEC	Atomic Energy Commission
ACE	Activity Control Envelope
ALARA	As Low As Reasonably Achievable
Board	Defense Nuclear Facilities Safety Board
BFO	Basis for Operation
BIO	Basis for Interim Operation
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
DOE	Department of Energy
EISs	Environmental Impact Statements
EM	Environmental Management
EPA	Environmental Protection Agency
ERDA	Energy Research and Development Administration
ES&H	Environmental, Safety and Health
HEPA	High-Efficiency Particulate Air
INEEL	Idaho National Engineering and Environmental Laboratory
JCO	Justification for Continued Operation
JHA	Job Hazard Analysis
LCOs	Limiting Condition of Operation(s)
LLNL	Lawrence Livermore National Laboratory
M&O	Management and Operation
NEPA	National Environmental Policy Act
NESS	Nuclear Explosive Safety Study
NPR	National Performance Review
NRC	Nuclear Regulatory Commission
OLs	Operating Limits
OSHA	Occupational Safety and Health Administration
OSH Act	Occupational Safety and Health Act
OSM	Occupational Safety Measures
PSM	Process Safety Management
QA	Quality Assurance
RCRA	Resource Conservation and Recovery Act
RFETS	Rocky Flats Environmental Technology Site
RMP	Risk Management Program
RWPs	Radiation Work Permits
SAR	Safety Analysis Report
TA-55	Technical Area-55
TEDE	Total Effective Dose Equivalent
TSRs	Technical Safety Requirements