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A Systematic Assessment of the Safeguards Regulations

Report

D. W. Fraley

NOVEMBER 1979

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Pacific Northwest Laboratory
Richland, Washington 99352

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2.0 APPROACH

To meet the study's objectives, it was necessary to develop a method by which each of the safeguards requirements could by systematically compared. In the study, we classified the regulations' contents and formulated a system for comparing and organizing the various requirements.

The approach has two steps. The first step creates a taxonomy for the safeguards regulations; it determines a set of categories and terms that can be used to classify the regulations' contents. By classifying each requirement as to whether or not it deals with some aspect of each term, insight regarding content and possible gaps in coverage can be gleaned. By grouping the regulations that deal with a common set of terms, insight regarding interactions and possible conflicts can be afforded.

The second step of the approach is the determination of structure. A basic assumption of this study is that the regulations can be represented by many structures. Each of the structures represents a different point-of-view or concern regarding the interpretation of their requirements. A result of the approach is a systematic basis for assessing the regulations.

2.1 SYSTEMATIC ASSESSMENT

The various safeguards regulations have different scopes, define different activities, and specify different functions. These real differences coupled with varying perceptions of the regulations give rise to potential conflicts in their interpretation and interrelations. The systematic assessment of the safeguards regulations is based upon several premises. They are:

1. *The safeguards regulations are complex, due in part to their purpose of promulgating requirements on complex activities.*

2. *Complexity makes interpretation of requirements and compliance with them difficult and often confusing.*

3. *One key to estimating and examining their complexity is a structural arrangement of the safeguards regulations.*

The performance of this study provides benefits beyond mere understanding of the contents and interrelationships of the safeguards regulations. A more orderly characterization will help assess the content of the regulations to determine if they are complete, consistent, or contradictory. It will help assure that changes or modifications interface with current regulations in an orderly manner.

In developing the methodology several additional assumptions were basic to the process:

4. *The safeguards regulations are a system, e.g., a complex unity of many, often diverse, parts serving a common purpose or plan.*

5. *The safeguards regulations deal with information in the form of requirements.*

The fourth statement establishes the fact that the regulations will be treated in a systematic fashion. They are not a system in the sense that they function in a physical environment, but rather that they serve a purpose. The system which the regulations embody deals with information in the form of requirements.

6. *Assessing a complex system is a two-phase process.*

The first phase requires that the system be broken down into its constituents or elements. The second phase is the aggregation of the elements along common lines. The elements may be grouped in differing ways which reflect alternative perceptions of their role within the system's structure.

The two phases may be referred to as creating a taxonomy and structuring. Taxonomy is the identification and definition of the properties of the system; i.e., a disaggregation. Taxonomy deals with definitions of intent, identification of elements to be included, and the naming of those elements. Structuring determines and characterizes the relations between elements. It includes the placing of elements into classes having common properties. The common properties and interactions are used to infer relations between the elements.

7. *Structuring results in alternatives rather than a unique characterization.*

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There is an additional aspect to the structuring process--that of relating the goals or behavior of the system to the interpretation of its structure. The information the safeguards regulations promulgate may be organized from a variety of viewpoints. Hence, the process results in alternative structures rather than a unique characterization. Each representation may be equally viable.

In summary, the systematic assessment of the safeguards regulations is founded on a number of assumptions. The assumptions have several common aspects with the study of systems in general. The key assumptions are:

- *The approach consists of two phases--disaggregation of the basic elements and collection of the elements as structures.*
- *The information which the regulations provide have alternative structural representations dependent upon the perspective of the person(s) interpreting their meaning.*

The remainder of this chapter details the methodology used to assess the safeguards regulations. The reader who is interested in the specific findings of this study may wish to proceed to the third chapter, referring back to this chapter only if certain terms or concepts presented there are confusing.

2.2 IDENTIFYING THE PARTS

The first stage of the approach is the development of a taxonomy for the elements of the safeguards regulations. This involves selecting a set of categories which can be used to classify the contents of the regulations. These groupings or categories are referred to as *"bases"*. As detailed in Chapter 3, a set of thirty-three bases was selected for grouping the elements of the safeguards regulations.

A base contains a set of similiar elements. For example, a base dealing with a specific function of the safeguards system would contain elements which characterize that function. Figure 2.1 depicts the structure of a base.

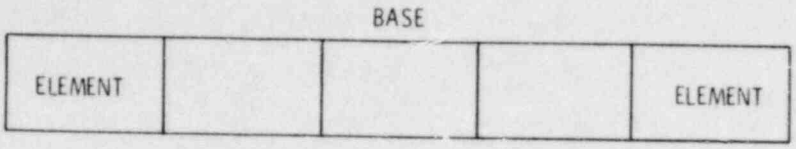

FIGURE 2.1. Elements in Base

For example, assume that access control is one of the functions of a safeguards system. As a base, access control may contain a number of elements such as identification procedures, searches, access registration, authorization criteria, door locking procedures, personnel escorts, etc.

Five related concepts can be defined as characterizing different aspects of the safeguards regulations. As an informational system, the safeguards regulations implicitly define safeguards *activity*. Each requirement, whether spelling out performance, specifying a procedure, or setting a standard, defines an activity of the system.

Objectives that motivate the creation of a requirement are a second organizational concept. The objectives of the regulations are the NRC's general aims or purposes such as protection of the public. A given regulation may have several objectives and specify a number of activities to meet a given objective.

Scopes bound the objectives by specifying the range of activities in the regulations. The activities may be further disaggregated by *function*. Functions are the procedures or actions necessary to carry out safeguards activities. The three terms are related in that the scope defines bounds on activities which meet the objectives, and functions focus the activities to specific actions.

Figure 2.2 depicts the relations of the terms defined in the above discussion. At the bottom of the hierarchy a set of *objects* is shown. These are the devices, physical materials, and the people that cause the functioning of a safeguards system. As shown, the various objectives, scopes, activities, functions, and objects are bases for organizing the safeguards regulations.

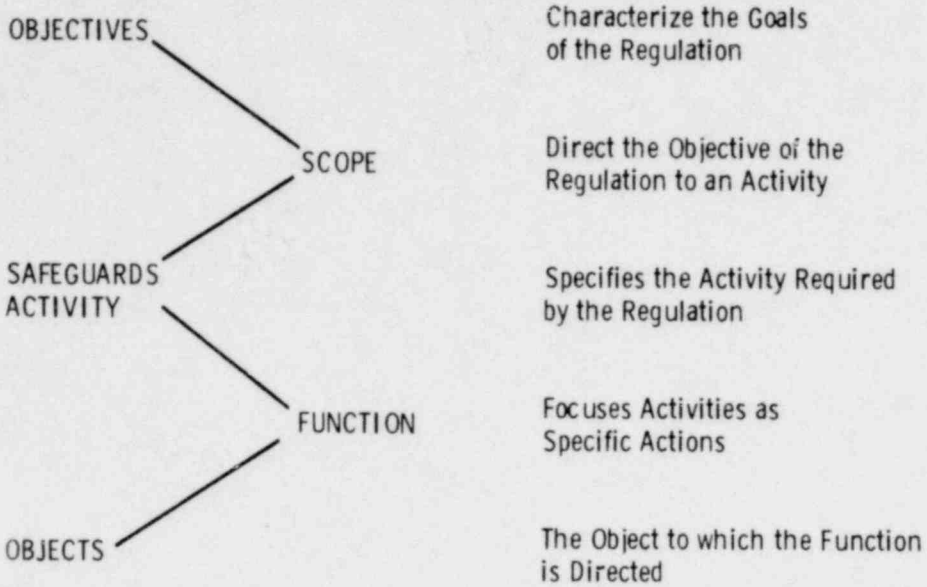

FIGURE 2.2. A Hierarchy of Elements for the Safeguards Regulations

To illustrate the various levels of bases in terms of Figure 2.2, consider the following *simplified example:* Assume that the objective of the safeguards regulations is to protect the public. Then the meeting of this objective could be measured in terms of effects on civil liberties and safety or health. These two aspects could be considered as elements related to the objective of the safeguards regulations. Assume further that the scope of the objective is oriented to adversary acts; adversary acts being separated into theft or diversion of material. Figure 2.3 depicts example elements[(a)] for the levels of the hierarchy given in Figure 2.2. The objective and scope of the regulations are met, for example, by prevention or deterrence of these adversary acts by access control and surveillance. Objects of the function may be alarms or guards.

(a) *This simplified example is used to introduce concepts that are developed in detail in Chapters 3, 4, and 6.*

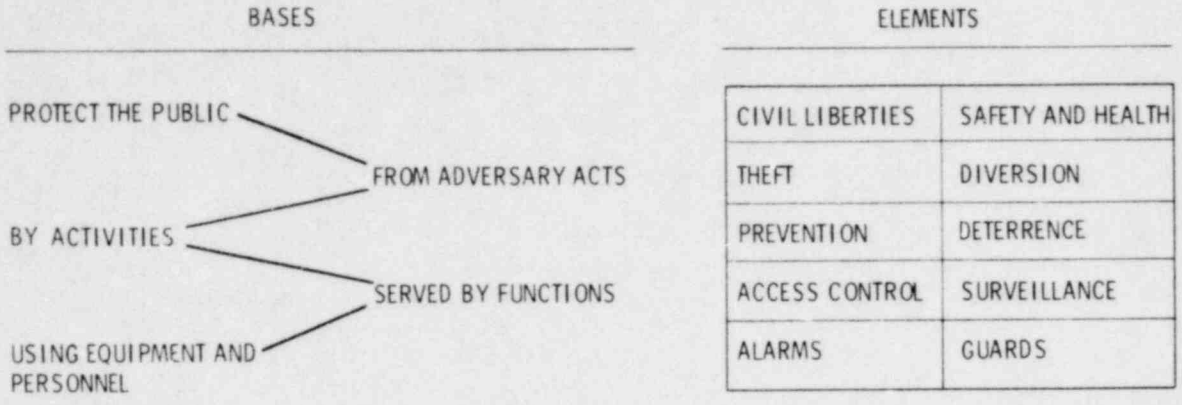

FIGURE 2.3. Example Elements

Use of the Bases. *Each regulation is subjected to review by first identifying the set of bases that apply to it.* The identification of bases appropriate to a given regulation is depicted in Figure 2.4.

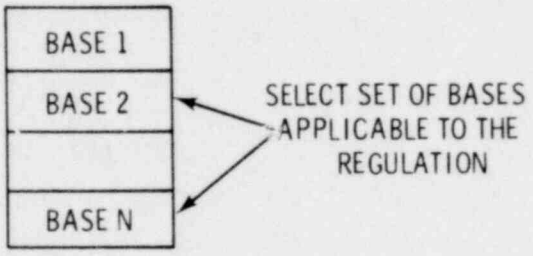

FIGURE 2.4. Set of Applicable Bases

Once the applicable bases are determined for a given regulation, the regulation's informational content is related to the elements contained in each base. This is determined for each section of the regulations for each applicable base. The Figure 2.5 depicts the relating of a given base's elements for a given regulation.

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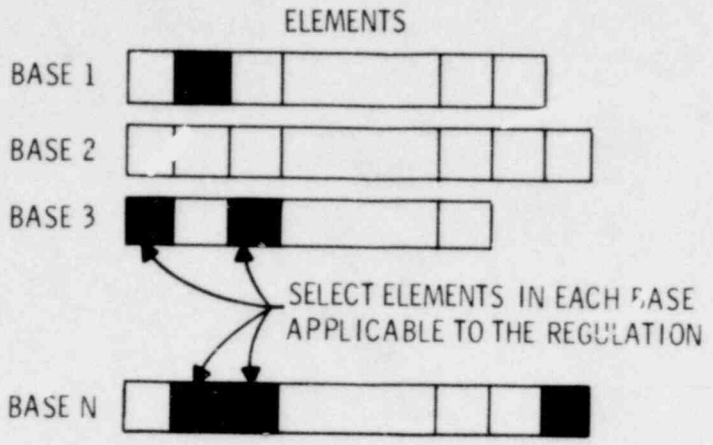

FIGURE 2.5. Set of Applicable Elements

Note that the process is essentially a check-off for the applicable elements in a given base. A degree of interpretation is necessary to determine the applicability of a given element. Each base has a different set of elements; there may be from three to thirty elements for a base. The selected bases are discussed in the next chapter and their elements are defined in Appendix B.

The notion of completeness of the classifying scheme may be considered in this context. A complete set of bases should allow classification of all the aspects of a given regulation. Assuming that the bases either singularly or in combinations cover all the aspects of the safeguards system, as specified by the information in the regulation, then a complete set of regulations will cover all the elements.

To exhibit the concept in more clarity, Figure 2.6 shows a set of marked elements classifying a regulation. A separate classification is made for each separate section of the regulations reviewed. The resultant set of classifications may then be compared for a given element in a given base. *This singular comparison process will first serve to identify an element which is not covered by any of the regulations.*

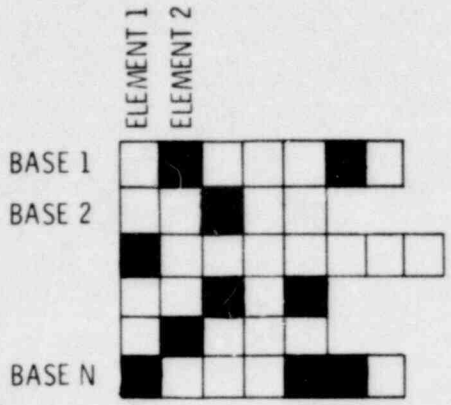

FIGURE 2.6. A Classification of a Regulation

A set of classifications is shown in Figure 2.7. The same element is considered in each. If that element is not covered in any regulation, then there may be a gap or incompleteness at the element level. *The singular comparison of an element with the same element in each classification also serves to identify multiple coverage of the element by several regulations.*

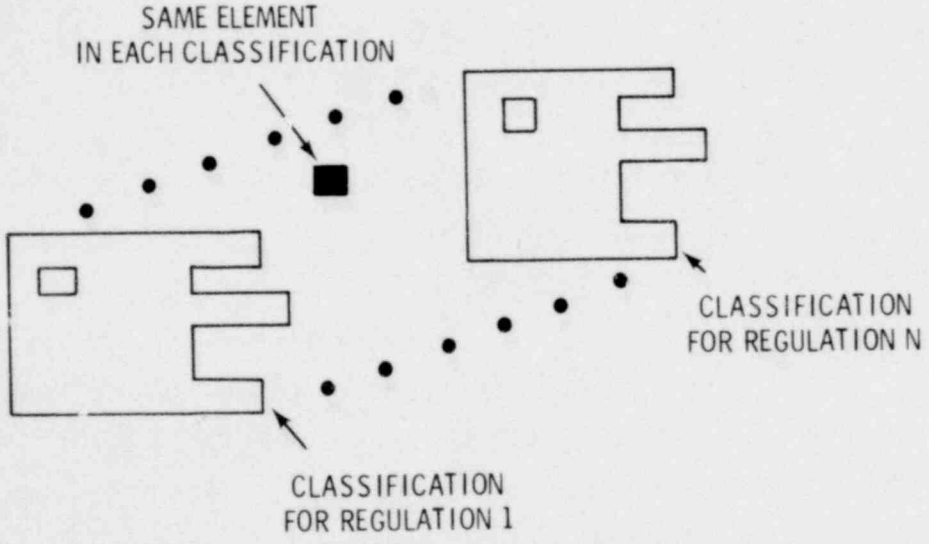

FIGURE 2.7. A Set of Classifications

This section has provided the basic concepts used in setting up an informational structure. The informational structure is composed of a set of bases containing elements. The classification of a given regulation, containing marked elements that describe the regulation's content, is the tool for decomposing the regulations into their constituents.

The determination and selection of the bases and elements for the safeguards regulations are discussed in Chapter 3. This is the first phase of the approach wherein all possible elements are identified and then related to the system under study. This provides a framework for the systematic assessment.

2.3 STRUCTURING

The bases form the disaggregated building blocks for aggregation into alternative structures. The completed classifications of the regulations are combined, compared, and ordered into structures for the safeguards regulations. In order to create the alternative structures, an overlaying intent structure is developed. An intent structure links the possible organizational perceptions of the meaning of the regulations with information contained in the regulations.

This section has two parts. The first deals with the concept of an intent structure. The second part discusses the methodology for aggregating the bases into structures.

Intent Structures

A number of documents that identify the purpose, goals, or objectives of safeguards are reviewed in Appendix A. Here, the view is taken that a structure for the regulations is dependent upon the intent or purpose of the regulations and the point-of-view of those people or organizations who must interpret or comply with their requirements. The different structures given by the various studies support this view.

Intent structures serve as methodological tools to help overcome some of the difficulties in defining goals and objectives and relating them to structure.(1) The intent structure is hierarchical in nature. The general hierarchical form of an intent structure is shown in Figure 2.8. The structure shows that objective statements are arranged in levels; a total of n levels is portrayed in the figure.

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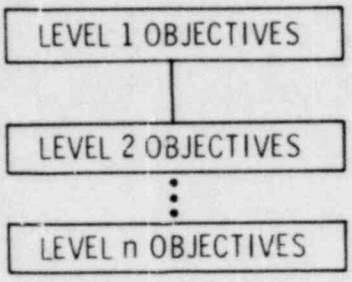

FIGURE 2.8. General Intent Structure

It is important to point out that the hierarchy presented in Figure 2.2 is an intent structure. At the upper levels of the hierarachy we have the overall goals of safeguards or the NRC. Below the top level, the objectives are translated into activities and activities into objects. In an intent structure these all have objective statements which are in support of higher-order objectives.

An objective statement is expressed in the following form:

To (Action Word)(Objective)(Qualifying Phrase)

By writing an objective statement for a use in a structure, the hierarchical relations can be more easily developed. An objective may be below another in an intent structure for either of two reasons:

1. If Objective A necessarily must be accomplished in order to accomplish Objective B, A lies below B in the intent structure.

2. If accomplishment of Objective C, either separately or in conjunction with other objectives, represents on alternative way of accomplishing Objective D, C lies below D in the structure.

Figure 2.3 gave a simple a example showing a set of elements that may exist at differing levels of a hierarchical structure. This example can be expressed in the form of a simple intent structure. This intent structure is exhibited in Figure 2.9. The objective statements at each level could be given as follows:

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Action Words	Objective	Qualifying Phrase
Protect	the public	by not restricting their civil liberties or health and safety.
Provide protection	against adversary acts	of theft or diversion.
Prevent or deter	adversary acts	by controlling access and surveillance.
Control access	(of potential adversaries)	by using alarms and guards.
Perform surveillance	of possible acts	by guard patrols.

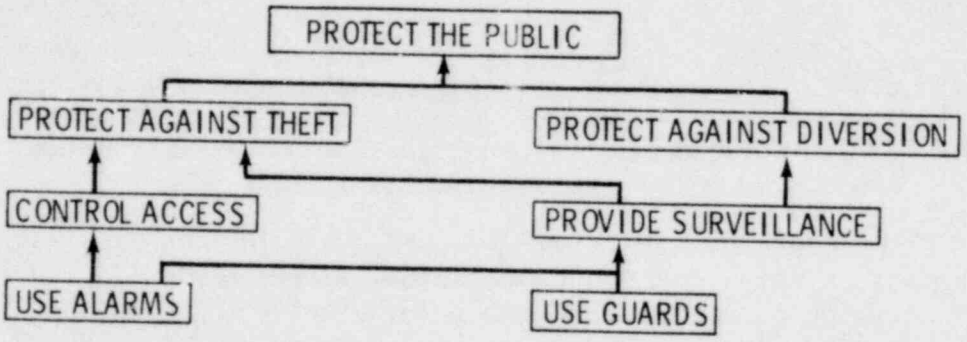

FIGURE 2.9. Example Intent Structure

At the highest level, the object for this example is to protect the public. Protection is to be provided against acts of theft or diversion. As shown in Figure 2.3, functions which provide protection are access control and surveillance provides protection against both diversion and theft whereas access control protects only against theft. Here, the objects supporting the functions are either alarms or guards.

Detailed sets of objectives of the safeguards regulations can be found in the summaries provided in Appendix A; particularly Section A.2.

Creating Structures

The information specified by the safeguards regulations is structured using an intent structure as discussed above. The alternative structures are created from the information contained in the classifications of the regulations coupled with an interpretation of the requirements spelled out in

regulations. An overall, general structure is not the objective, but rather, a set of possible structures based upon alternative ways of perceiving the regulations.

Four major steps are required to develop a hierarchical structure. These tasks are as follows:

1. *Identify a relevant set of elements.* In this case the number of elements in a safeguards system as specified by the regulations is quite large. As a result, a preliminary set of element groupings, the bases, was developed. To some degree, the grouping of the elements within bases imparts a judgment that the elements are at an equal level in a hierarchical structure. However, bases need not restrict the structuring process; rather, they break down the structuring process into manageable pieces.

2. *Classify the regulations.* This involves a careful reading of the requirements and the identifications of all the appropriate elements which characterize each requirement. The definition of appropriate elements and bases is necessarily an iterative process.

3. *Group the bases for possible structures.* Select appropriate bases which characterize possible ways to organize the regulations. Depending on the point of view there may be alternative ways to order the bases to represent structures. The selection and depiction of alternative structures is given in Chapter 6.

4. *Create structures.* Develop objective statements for the selected bases which represent possible ways for structuring the regulations. Compare the bases to determine precedence relations and combine as a structure.

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3. Harary F., R. Norman and D. Cartwright. 1965. Structural Modes: An Introduction to the Theory of Directed Graphs, John Wiley and Sons, New York.

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3.0 CLASSIFICATIONS FOR THE SAFEGUARDS REGULATIONS

This chapter discusses the thirty-three categories, or bases, that were selected for classifying the contents of the safeguards regulations. They were found by using the various interpretations of the structure of the regulations. Each base contains a number of elements that characterize the contents of the regulations.

In order to select the bases and identify their elements, a number of safeguards studies and NRC documents were reviewed, most of which describe safeguards structures. Because the purposes of the sources differ, various structures are presented to support the specific objectives of each.

Appendix A presents the categories used by various sources to organize the safeguards regulations. Section A.1 surveys how safeguards concerns are organized by NRC. A number of safeguards studies also provide organizations for various safeguards concerns; these are discussed in Section A.2.

The bases that were selected and their use are given in this chapter. The detailed contents of the bases are given in Appendix B. Chapter 4 then classifies the regulations by relating their contents to the specific bases that were selected.

3.1 DETERMINING BASES

The organization of a structure for the safeguards regulations has a set of elements as its fundamental building blocks. These elements are related to one another by the activity or general safeguards concern that they support. The groups of related elements are referred to as bases.

A number of possible organizations may be used to structure the safeguards regulations; these are detailed in Chapter 6 of this report. Here the structural concepts introduced in Chapter 2 are used to determine the set of bases.

The various organizations of safeguards concerns deal with specific goals or objectives. Each is oriented to a specific purpose and is presented in a manner that reflects a given point of view. A structure for the regulations should have the following characteristics:

1. *Meeting general NRC objectives*, e.g., providing the general public insulation from possible burdens in terms of civil liberties, institutional, economic, environmental, health, or safety impacts.

2. *Directing the general objectives by specific intents to the scope of safeguards activities*, e.g., safeguards are directed at achieving a level of protection against acts such as the unauthorized possession or use of nuclear materials or destruction of facilities dealing with nuclear material.

3. *Specifying safeguards activity*, e.g., defining measures which are designed to achieve some level of protection by deterring, detecting, preventing, defending, etc., against possible acts.

4. *Identifying the functions which focus the safeguards measures as specific actions*, e.g., to detect possible acts, material must be accounted for; to deter, the public must be aware of the measures which serve as penalties for possible acts, etc.

5. *Defining the objects to which the functions are directed*, e.g., the specific facilities, operations, materials, equipment, etc., towards which a function is directed or which are necessary to carry out the function.

The various categories which serve to organize the regulation's contents appear at any level in the above hierarchy. However, at the top level there is a general consensus on the overall objective. On the other hand, the objects have a multitude of possible groupings. Possible bases for each of the levels of the above hierarchy are listed below:

1. Bases related to the general safeguards objective. Although it can be stated in different ways, the objective of safeguards deals with the relation of the public to the impact of safeguards activity. The objectives may be grouped as:

   A. Safety and health.
   B. National security.

   Other indirect objectives may include:

   - National interest, national energy goals, and international cooperation.
   - Environmental protection, conservation, property rights, and land use.
   - Monetary and financial control, economic impact.
   - Law enforcement.

2. Bases related to the scope of safeguards activities. The scope specifies the range of activities necessary to meet the safeguards objectives. Categories include:

   A. Safeguards strategy--usually material control and accounting or physical protection. Also may identify material protection as separate from protection of facilities or operations.
   B. Type of adversary acts, which may include covert or overt theft of material, sabotage, or hoaxes.
   C. Performance required of the safeguards system in meeting the objective.
   D. Items of concern that separate the scope of direction between facilities or operations and concern with nuclear material.

3. Bases specifying safeguards measures or activities. These characterize the general kinds of actions or activities within the scope of consideration. They are:

   A. Safeguards intent--the expression of the kind of actions considered. Includes such actions as: prevention, deterrence, detection, control, protection, consequence reduction, etc.
   B. Nature of the activity--whether the measures deal with procedures or with specifications. Procedures may be further separated into 1) administrative, 2) scientific and technical, or 3) analytical or evaluative.
   C. Regulatory activity such as: licensing, inspection, enforcement, or research.

4. Bases specifying safeguards functions. This level focuses the scope and activities to specific objects. Categories include:

   A. Access control.
   B. Surveillance.
   C. Investigation.
   D. Response.
   E. Planning and design.
   F. Records and reports.
   G. Deterrence.
   H. Assurance.
   I. Security organization.
   J. Accounting.
   K. Communications.

5. Bases defining objects of the safeguards system. A general separation can be made between objects which are necessary for the function of the system and objects which further qualify the function's purpose.

   Objects that serve a function are:

A. Security areas.
B. Intrusion and detection devices.
C. Alarm and communication systems.
D. Protective equipment.

Objects which delimit the function are:

E. Material types.
F. Facility types.
G. Mode of transport.
H. Adversary characteristics.

Material may be further quantified by its:

I. Measures.
J. Elemental forms.

Specific functions of the safeguards system may be further delineated by specifying a:

L. Designated responsible party.
M. Location in the system.
N. Time phase of the facility or operation.

All of the sources reviewed in Appendix A for the purpose of organizing the structure of the safeguards regulations deal with some of the aspects of each set of possible bases above. The hierarchy is presented to help clarify the possible ways of depicting or conceptualizing structures. All the structures presented contain various subsets of functions and objects, at the lower level of the above hierarchy. Recall Figure 2.2 which depicted the same hierarchy for the purpose of presenting the methodology.

3.2 THE BASES

Bases were selected from the categories given above. The bases primarily relate to the activities, functions, and objects of the safeguards regulations. Within each base selected is a set of elements. The elements are terms which characterize the attributes, specific subfunctions, or objects that are related to the given ba.

Categories dealing with the objectives of safeguards were not selected as bases. The bases were selected on their potential for being included in

one or more of the alternative structures for the safeguards regulations. They were also selected for their applicability in reviewing the content of the regulations.

Appendix B defines each of the elements in the context of the set of bases. This section briefly discusses each base and summarizes the selection of the elements contained in each base. The order of their presentation is arbitrary and does not follow the hierarchical presentation of the above subsection. For the purpose of reviewing the content of the regulations, and for structuring, the bases are treated individually. The bases are:

Base 1 - Regulatory Requirement. There is some issue about how to define regulations in terms of performance, allowing the licensee to propose systems which meet the requirements or defining specification. This base is used to categorize regulations with regard to the form and detail of their requirement. It contains three elements to determine if a given regulation is a:

A. Goal Requirement, giving the primary purpose or objective to be achieved; or
B. Performance Requirement, giving the output and level of performance required; or
C. Procedural Requirement, specifying procedures or equipment necessary to meet requirements.

Base 2 - Regulatory Activity. Those activities conducted by the NRC to meet the requirements of their charter. They include such activities as rulemaking, licensing, inspection, enforcement, research, standards, etc. Each regulation deals with some aspect of regulatory activity. However, the majority deal with licensing. There are ten elements in this base used to characterize the various regulatory activities. They are given on pages B-7 and B-8 of Appendix B.

Base 3 - Designated Party. The identified individuals or groups who must comply with regulations or are legally responsible for noncompliance. The majority of regulations refer only to "persons" which may be individuals or organizations. This base expands the term into thirteen elements

exemplifying different persons or groups. The most common element is the licensee, but the regulation may also refer to their employees, contractors, government agencies, etc. The NRC is also a possible designated party having responsibility in the compliance of certain regulations. Definitions of each element are given on pages B-10 through B-12.

Base 4 - Safeguards Intents. This base characterizes the general kinds of actions or activities within the scope of the regulation considered. Each element is expressed as an action statement in the form of a verb phrase. In many statements of objectives for safeguards systems, elements of this base are given as aims or purposes of the safeguard function being considered. This base also serves to define each of its elements in a manner that avoids overlap and the possible confusion that occurs with different interpretations of the various terms. The terms included in this base are:

A. Prevention.
B. Deterrence.
C. Containment.
D. Control.
E. Detection.
F. Apprehension and recovery.
G. Consequence reduction.
H. Protection.
I. Defense.
J. Assurance.

The actions of deterrence, assurance, and consequence reduction also serve as possible functions which are treated as separate bases. Bases 19, 20, and 33 deal respectively with the activities related to deterrence, assurance, and consequence reduction.

Base 5 - Facility Type. The safeguards regulations define a facility to be a reactor, a critical facility, a conversion plant, a fabrication plant, a reprocessing plant, an isotope separation plant, or a nuclear material storage location, containing or to contain nuclear material. Several alternative definitions which appear in the regulations are also included as elements in this base.

Base 6 - Fixed Site Operation. Within a given facility there are a number of production activities and physical processes that take place.

These are, to a degree, related to the nuclear fuel cycle. At various steps of the cycle, specific safeguarding activities may be required. The elements of this base are defined on pages B-22 to B-25.

Base 7 - Transit. This base has the various modes of transportation as elements. Also included are transfers, stops, and whether a shipment is an import or export. Regulations regarding transit operations are generally specified along the various modes or activities in this base.

Base 8 - Time Phase of Facility. The regulatory process is often related to the temporal aspects of a facility. The elements of this base span the time horizon of a facility from planning to operation to decommissioning. Also included are the abnormal operational modes whereby certain active safeguards mechanisms may be required. Pages B-21 to B-31 give the thirteen elements of this base.

Base 9 - Material Type Classification. Nuclear materials are often given names or classification based upon their use or value to potential adversaries. They are also sometimes classified relative to a specific production process. Although special nuclear material is the primary concern of the regulations, a number of other classifications also appear. The principal classifications making up the elements of this base are:

A. Special nuclear material.
B. Source material.
C. Strategic special nuclear material.
D. By-product material.
E. Waste and/or scrap.
F. Fissile material.

The use of the material type classifications is common in the regulations but not consistent. For example, fissile material is essentially special nuclear material. Eight other classifications are also given the base.

Base 10 - Elemental or Isotopic Forms. The material type classifications are based on mixtures of, or specific, nuclear materials. This base simply lists a number of isotopic forms of the various elements which are often considered to be nuclear materials.

Base 11 - Material Measures. In addition to being classified by their constituents or use, nuclear materials are classified by various measures. The principal characterizations are:

A. Weight.
B. Radioactivity.
C. Percent enrichment.

Other classifications that are based on measures of material quantities or special forms are:

D. Fissile classification.
E. Effective kilograms.
F. Special form.
G. Critical quantity.
H. Significant amount.

These elements are defined in Base 11 on pages B-39 to B-44.

Base 12 - Safeguards Performance Criteria. The terms defined in this base relate to performance of safeguards systems. The base does not include actual measures which are used to evaluate system effectiveness, but rather, terms which are used to describe effectiveness. This base is used in classifying regulations that have performance as an objective. Several of the elements of this base also correspond to the safeguards intents (Base 4) but are identified here as part of performance. Pages B-46 to B-48 list the nineteen elements contained in this base.

Bases 13 through 23 contain a set of functions of safeguards systems. These were identified in the hierarchy given in the previous subsection.

Base 13 - Access Control. The first function, access control, is the monitoring and enabling of authorized movement of personnel, vehicles, and packages entering and exiting security areas. The base contains twenty-nine elements related to the function. General concerns of access control are authorization, personnel and package access, and procedures to grant access. Access to material during transport is also considered herein. In reviewing the elements listed on pages B-50 through B-52, note that the elements are somewhat interrelated although treated as equals. For example, the entry of personnel would require access authorization, identification, badge display,

confirmation and associated procedures required to allow access. A subset of the elements of this base would all be associated with the process of gaining access. The interaction of the various elements would define a structural relation.

Base 14 - Surveillance. Surveillance is the direct or indirect observation of individuals and/or materials to detect activities potentially involving access to nuclear material for diversion. By its definition, surveillance is supportive of the safeguards intent of detection. The various activities or subfunctions of surveillance are listed as elements within this base. Included are temporal factors, monitoring, the role of guards or other personnel, and procedures. As with the other bases which describe safeguards functions, the elements, although interrelated, are all listed at an equal level.

Base 15 - Investigation. Investigation is the systematic inquiry, examination, identification and assessment of activities, or circumstances to prevent, avoid, or alert of potential compromise of a safeguards system. Investigation can be characterized as two general activities. The first part of investigation occurs a priori and continuously serves the safeguards intent of prevention. Investigation also takes place as the result of specific events. The base lists a number of kinds of events which require investigation as well as the continuous information required to prevent possible events. Once an event is identified, part of the purpose is to assess for possible response. Assessment for response is part of the next base. Pages B-57 and B-58 define the elements associated with investigation.

Base 16 - Response. Once the investigation has identified or characterized an event, the response function may be initiated. Response may only require that the identified event be assessed, determining that no actual response is required. Response is a reaction taken to interrupt or delay an adversary's action sequence, to recover lost material, and to reduce potential consequences of an adversary's end event. The specific set of adversary action sequences are given as Base 32. Response entails assessment of events, procedures and tactics, and actual actions taken. These elements are given on pages B-60 and B-61.

Base 17 - Planning/Design. The conduct of safeguards functions and the design of safeguards systems all require planning. Planning is the a priori activities which provide assurance of safeguards systems performance in all phases of operation and conformance with applicable regulatory requirements. A portion of the planning process involves design. The design process is often based on performance requirements which are called design bases. The elements of the base are the design bases and procedures which require a priori planning of the operation of a safeguards system. The twenty-three planning elements are defined on pages B-63 through B-65.

Base 18 - Records and Reports. All the safeguards functions and operations require documentation. The principal forms of documentation deal with material status and specific incidents. Other records may be kept regarding communication, personnel, and tests and inspections. The elements of this base are primarily related to the various safeguards system functions which they serve to document.

Base 19 - Deterrence. Deterrence is a safeguards system function which discourages or causes potential adversaries to refrain from or voluntarily halt a sequence designed to obtain or misuse nuclear material. It is a passive function, unlike response which functions actively. Possible deterrents include legal sanctions, signs, warnings, control of information and other measures which can be taken to discourage material misuse. Pages B-70 and B-71 list the fourteen elements defined for this base.

Base 20 - Assurance. The assurance function is served by measures to satisfy the public and NRC that safeguards are in place and can provide protection against attempted acts that would increase the risk to the public's health, injury, or property damage. Methods of providing assurance include, tests, drills, maintenance, inspections, and quality assurance programs. The fifteen elements associated with the assurance base are given on pages B-73 and B-74.

Base 21 - Communications. Another separable safeguards function is the transmission of information other than by records or reports. Communication may be voice or coded signals over communication devices. The requirements for communication under both normal circumstances and during events form

the elements of this base. Communication can occur within a facility, to locations outside a facility, or during transport of material. Elements include scheduling, procedures, locations, maintenance, and other related factors.

Base 22 - Security Organization. The function of a safeguards system requires an organization of the people, equipment, and functions in an organization. The management of the organization, responsibilities, training, etc., form the elements of the security organization. Fourteen elements are defined on pages B-79 and B-80 of the index given in Appendix B.

Base 23 - Accounting. A primary technique or strategy used for safeguards is material accounting. Accounting serves the safeguards intent of exercising control or protection by making certain or verifying that material quantities are measured, enumerated, or recorded. The activities of material accounting are usually performed in the context of a material accounting system. The material accounting system is that part of the safeguards system emcompassing the procedures and systems to 1) perform nuclear material measurements, 2) maintain records, 3) provide reports, and 4) analyze data to account for nuclear material. There are a number of specific terms and activities associated with nuclear material accounting. Base 23 lists twenty-five elements which are associated with the various activities of material accounting. The elements are defined on pages B-82 to B-87.

Bases 24 to 28 include safeguards system objects which serve the various safeguards functions. The groupings are somewhat arbitary in that some of the objects in a given base may serve different functions or purposes. The general categories are: Base 24 - Intrusion and Detection Devices, Base 25 - Alarm and Communication Systems, Base 26 - Security Areas and Base 27 - Armament and Protective Equipment. Other possible equipment, or devices, are included in Base 28.

Base 24 - Intrusion and Detection Devices. Intrusion and detection devices function in conjunction with alarm and communication systems. The devices or objects included in this base provide support for the detection functions. They include various types of detection, testing, and monitoring equipment.

Base 25 - Alarm and Communication Systems. Upon detection, alarms provide automatic annunciation of the occurrence of events whereas communication systems are used to announce events by personnel. Communication systems may be viewed as being used after the investigation of an occurrence. The specific types of alarms and communication devices are the elements of this base. They are defined on pages B-92 and B-93.

Base 26 - Security Areas. An area is an enclosed physical space designed for some purpose. It may be designated by barriers and be subject to access controls. This base lists the types of barriers and designations of security areas ranging from perimeters to packages. Specific requirements contained in the regulations deal with the designation of security areas and the types of devices they use to define their realm of control. Included among the twenty-nine elements of this base are portals, vaults, area designations, and equipment specifications.

Base 27 - Armament, Protective Equipment. This base includes equipment or devices which are used by safeguards personnel for the purpose of physical protection. Included are armament, specifications, and protective equipment. The elements are given on page B-100 of Appendix B.

Base 28 - Other Safeguards Equipment. This base includes locks, keys, vehicles, etc., which are used by safeguards personnel or are the object of safeguards functions. This base is essentially a "catch-all" for items of equipment not identified as part of the above four bases.

Base 29 - Location in Safeguards System. This base is used to identify the location of either material or persons physically within the safeguards system. For adversaries, their location may require a specific type of response. For material, location may make it more vulnerable and have different controls or protective requirements. The security areas defined in Base 26 are also directly dependent on their location, with respect to access to material. The elements of this base are arranged in a hierarchy from off-site or in transit to the point of physical access to material.

Bases 30, 31 and 32 deal with the adversary, and are oriented to the scope of safeguards activity dealing with the type of adversary acts.

Base 30 - Adversary Characteristics. This base lists attributes or characteristics of possible adversaries. The elements include a) number of personnel, b) degree of access, c) intelligence, d) armament, e) knowledge and expertise, f) dedication, g) organization, h) resourcefulness, i) backing, and j) the existence of insiders. Performance-based regulations are often oriented to specific descriptions of potential adversaries. Adversary characteristics are defined on page B-107.

Base 31 - Type of Adversary Action. This base lists the possible adversary acts generally considered as threats to the safeguards system. Included are covert and overt theft, diversion, sabotage, and hoaxes.

Base 32 - Stage of Adversary Action Sequence. The adversary activities can be arranged in chronological sequence. Specific safeguards functions may relate to one or another of the possible stages of the sequence. Ten steps of adversary actions are given in this base; they range from recruiting perpetrators to fulfulling of intent (which may include the planned use of the material). Page B-111 of Appendix B lists the adversary action sequence elements.

Base 33 - Consequence Reduction. Consequence reduction includes mechanisms or actions which reduce the losses to society which may be caused by the perpetration of an adversary act. The mitigation of effects is an additional function of the safeguards system which deals with methods to reduce possible societal risks. Nine elements are defined on pages B-113 and B-114 of Appendix B.

The Elements. Appendix B lists over 450 different elements in the thirty-three different bases. The bases and their elements are used in the fourth chapter to classify the regulations by relating their contents to the elements of each of the bases. In the sixth chapter, the bases are again used for the development of alternative structures.

It is important to note that the selection of the elements and the associated bases is an iterative process. The set of categories selected as bases are partially dependent upon their use in classifying the regulations' contents and in exhibiting alternative structures. Paradoxically, the structures depend on the bases and elements which form their interrelated

parts. The categories and elements discussed in this chapter and in more detail in Appendix B are the result of several iterations of the structuring process.

3.3 CLASSIFYING THE REGULATIONS

In Chapter 2 the notion of a set of bases containing elements related to safeguards concerns was introduced. The set of bases can be grouped together in a matrix which is used for classifying the content of a regulation. Figure 3.1 depicts the matrix used to classify the regulations. Each row corresponds to one of the bases introduced in Section 3.2. The columns, labeled A, B, C, etc., correspond to elements of the bases.

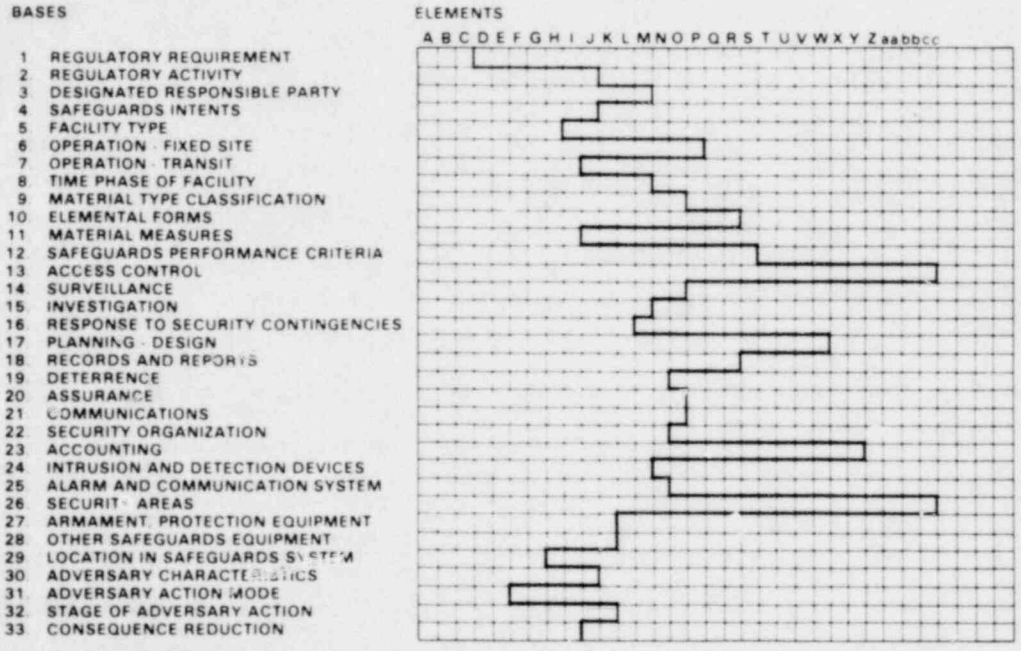

FIGURE 3.1. The Matrix of Bases and Elements

Notice in Figure 3.1 that the length of each row is different. For example, row 4, corresponding to the base Safeguards Intents, contains ten elements labeled A through J. Each element in the matrix corresponds to one

element in a given base. To illustrate, the fourth element in the fourth base corresponds to control: that is, to exercise direction over use and location of SNM. The complete list of elements is given in the Safeguards Index (Appendix B).

Each of the numbered sections of the regulations was reviewed for content using the tableau shown in Figure 3.1. If a given section dealt in some way with the aspects or the attributes of a given element then that element was marked as covered by that requirement.

Two major factors must be considered before using this approach to classify the regulations. First, where a section does not explicitly refer to a given element, reference to a given element may be implied. The determination of coverage, in this instance, requires a subjective decision. Second, this approach only indicates the content of a regulation. The resulting classifications must than be carefully reviewed where gaps or overlapping coverage are indicated.

Figure 3.2 shows the classification for Section 73.30, Physical Protection of Nuclear Materials in Transit: General Requirements. The elements filled

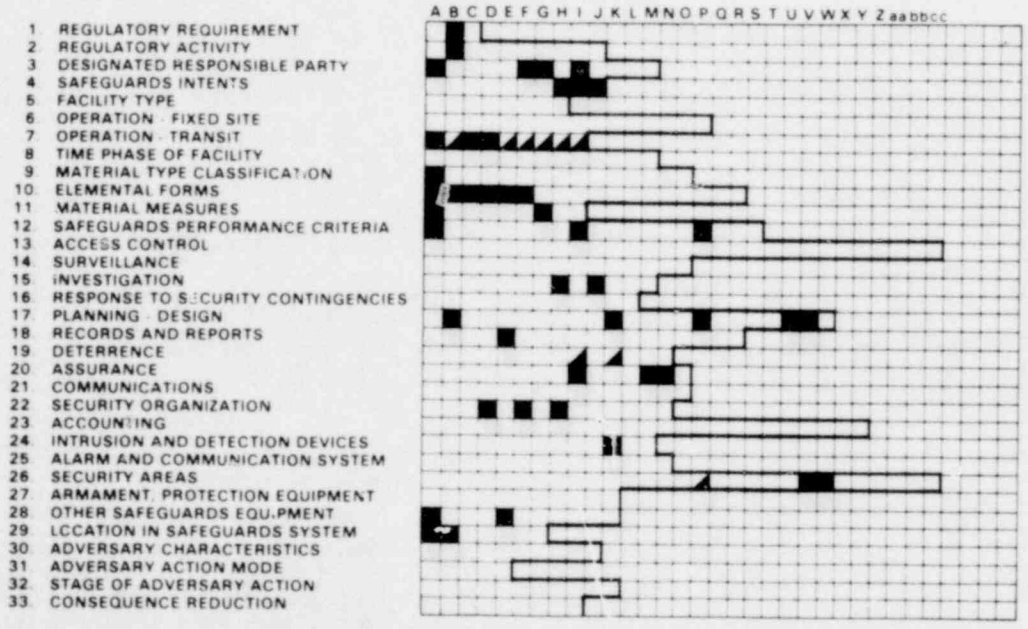

FIGURE 3.2. Example List Structure for 73.30, 10 CFR

in black indicate that the regulation deals with that specific element. Notice that some elements are marked along the diagonal of the cell rather than completely covered. This indicates a subjective judgment concerning coverage. Elements which are clearly covered but not explicitly identified are also marked in this manner.

Section 73.30 deals with the general requirements for physical protection during transit. Table 3.1 reproduces the content of this section for reference. In reviewing the content, the section was queried with respect to each base.

The general content of Section 73.30 specifies the minimum material quantities that require physical protection during shipment. In Figure 3.2, Element B in the first base is marked, indicating that the regulation gives a performance requirement. The general area of regulatory activity that Section 73.30 deals with is licensing. Paragraphs (e) and (f) in Table 3.1 indicated the licensing activity.

The third base, Designated Party, has the following elements checked in the list structure: A - Licensees; F - Employees of the Licensee, e.g., guards as indicated in paragraph (d); G - Carriers, from paragraph (a); and I - Nuclear Regulatory Commission as mentioned in paragraph (f). Each of these parties interacts with Section 73.30 or is subject to its requirements.

Establishing Safeguards Intents (Base 4) often requires a subjective judgment in the review of a given regulation. For this example, the protection activity is specified by the Section's title. Figure 3.2, the elements I - Defense, and J - Assurance, are also marked as intents of this regulation Base 4, the protection element is separate from the defense element, to distinguish between the act of guarding and the capability to respond or defend. Most of the regulations serve to provide assurance.

Bases 5 and 6 are blank because Section 73.30 does not deal with facilities or operations at fixed sites. All the elements of Base 7, Transport, are marked in Figure 3.2. Although transit implies all the operations and various modes listed as elements in the base, only road, rail and sea are explicitly mentioned in paragraph (c). The other elements in the base are marked to

TABLE 3.1. Facsimile of Section 73.30, 10 CFR

PHYSICAL PROTECTION OF SPECIAL NUCLEAR MATERIAL IN TRANSIT

§ 73.30 General requirements.

(a) Except as specified in § 73.36(a) or as otherwise authorized pursuant to § 73.30(f), each licensee who transports or who delivers to a carrier for transport either uranium-235 (contained in uranium enriched to 20 percent or more in the U-235 isotope), uranium-233, or plutonium, or any combination of these materials, which is 5,000 grams or more computed by the formula, grams = (grams contained U-235) + 2.5 (grams U-233 + grams plutonium), shall make arrangements to assure that such special nuclear material will, if a common or contract carrier is used, be transported under the established procedures of a carrier which provides a system for the physical protection of valuable material in transit and requires an exchange of hand-to-hand receipts at origin and destination and at all points enroute where there is a transfer of custody.

(b) Transit times of shipments other than those specified in § 73.1(b)(3) shall be minimized and routes shall be selected to avoid areas of natural disaster or civil disorders. Such shipments shall be preplanned to assure that deliveries occur at a time when the receiver at the final delivery point is present to accept receipt of shipment.

(c) Special nuclear material shall be shipped in containers which are sealed by tamper indicating type seals. The container shall also be locked if it is not in another container or vehicle which is locked. If inspection of the container or vehicle is not required by State or local authorities before final destination, the outermost container or vehicle shall also be sealed by tamper indicating type seals. No container weighing 500 pounds or less shall be shipped in open trucks, railroad flat cars or box cars and ships. This paragraph does not apply to shipments of quantities specified in § 73.1(b)(3).

(d) When guards are used pursuant to §§ 73.31(c)(1), 73.31(c)(2), 73.33 and 73.35, the licensee shall not permit an individual to act as a guard unless there is documentation that the individual has been qualified by demonstrating an understanding of his duties and responsibilities. The licensee or his agent shall have documentation that guards have been requalified annually.

(e) By January 7, 1974, each licensee shall submit a plan outlining the procedures that will be used to meet the requirements of §§ 73.30 through 73.36 and 73.70(g) including a plan for the selection, qualification, and training of armed escorts, or the specification and design of a specially designed truck or trailer as appropriate. This plan shall be followed by the licensee after March 6, 1974.

(f) A licensee or applicant for a license may apply to the Commission for approval of proposed procedures for transport of special nuclear material in a manner not otherwise authorized by the regulations of this part. Such application shall include a description and quantity of the special nuclear material involved, the origin and destination, the carriers to be used, the expected time in transit, the number of transfer points, the communications to be used, the vehicle visual identification, and the cargo security and surveillance measures to be used.

(g) Paragraphs (b), (c), (d), and (f) of this section are effective March 6, 1974.

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denote implied coverage. Regulations 73.31 through 73.36 all support the general requirements of this section. Hence, all aspects of transit are implicitly covered in this section.

Base 8, Time Phase of Facility, deals with fixed sites and is not covered by Section 73.30.

Bases 9, 10 and 11 all deal with material. In Section 73.30 the material of concern is SNM, denoted by element A in Base 9. Special Nuclear Material can contain plutonium or enriched uranium isotopes listed as elements A through F in Base 10. Material quantities are specified by weight (element A, Base 11) and by formula quantity of 5000 grams (element G, Base 11).

Base 12 has possible performance criteria as elements. For Section 73.30, three elements are checked as shown in Figure 3.2: A - Protection, I - Timeliness, and P - Material Attractiveness. Protection and timeliness are specifically mentioned in the context of the regulation. Material attractiveness is a property of the amount and kind of material requiring protection.

Although Access Control (Base 13) and Surveillance (Base 14) are bases which should be related to material protection in transit, Section 73.30 makes no mention of any of these activities. No elements of either of these bases are marked in Figure 3.2. The elements of these bases are covered to a degree by Sections 73.31 through 73.36.

Paragraph (b) of Section 73.30 indicates the selection of routes to avoid areas of natural disasters or civil disturbances. Elements H and J require investigation to determine location and magnitude of events which might jeoparidze the shipment of material. The two respective elements are marked in Base 15, Investigation.

Section 73.30 does not indicate any response functions beyond the existence of a plan for physical protection (paragraph (e)). This is included as part of Base 17, Planning and Design, and no response activities are marked as covered in Base 16. The design for a physical protection system; planning for handling; storage and shipping; locked, secured containers; schedules; and shipping plans are all mentioned in the regulation. Each of the respective elements of Base 17 dealing with these considerations are marked in Figure 3.2.

The only records mentioned as part of the requirements of Section 73.30 deal with shipping records and receipts, in paragraph (a). This is element E - Shipping Records, listed under Base 18 - Records and Reports.

Section 73.30 does not explicitly deal with the deterrance function as defined in Base 19. However, implicit in the content of the regulations are vehicle markings and the restriction of information regarding shipping plans. These two elements are marked in Base 19, in Figure 3.2, to flag the consideration of these deterrence activities.

Base 4, Safeguards Intents, subjectively considered one of the intents of Section 73.30 as being assurance. Base 20, Assurance, lists as elements a number of possible assurance activities. Paragraph (d) of Section 73.30 mentions guard qualifications (element I, Base 20). Paragraph (c) indicates plans to avoid natural disasters or civil disturbances. Elements M - Contingency Plans and N - Avoidance of Population Centers, of Base 20, are marked in Figure 3.2 as the assurance functions Section 73.30 may provide.

Section 73.30 does not consider communications or material accounting as defined in Bases 21 and 23, respectively. The qualification, training and duties of guards are mentioned in paragraph (d). These elements are parts of Base 22, Security Organization.

Bases 24 through 28 deal with the devices which may be required by the safeguards regulations. Section 73.30 mentions seals (element K, base 24), and containers or containment (elements V and W, Base 26). Note in Figure 3.2 that element P of Base 26, dealing with packaging, is also marked. Paragraph (c) of Section 73.30 can be considered to be concerned with some aspect of packaging. Other safeguards equipment mentioned includes locks (element A, Base 28) and Special Transport Vehicles (element E, Base 28). These items are marked in the example list structure given in Figure 3.2.

The final base marked in this example is Base 29, Location in the Safeguards System. Section 73.30 deals with transit operations which occur offsite between facilities. The appropriate elements are marked as part of the base in Figure 3.2.

Each of the regulations has been similarly reviewed and classified. Because there is some degree of subjectiveness in determining coverage and because of their obvious detail, the classifications are not presented in this report. The results of the review and the major considerations are given in the following chapter.

It is important to note that the methodology used to classify and characterize the content of the regulations requires some subjectivity in its use. The displays presented in the next chapter are by no means absolute. A number of elements within the set of bases were difficult to define and may require some modifications. Similarly, to truly determine the content of the regulations, careful reading and knowledge of their application are required.

4.0 CONTENT OF THE REGULATIONS

This chapter addresses the content of the safeguards regulations; it discusses their completeness by classifying each with respect to its coverage. The methodology developed in Chapter 2 is used for this purpose. Each regulation contained in Parts 70 and 73 of 10 CFR is reviewed and classified using the bases developed in Chapter 3 and listed in Appendix B.

The sections provide a base-by-base review of the regulations' contents. In Section 4.1, three bases dealing with regulatory requirements are considered. Sections 4.2 and 4.3 review the regulations from the viewpoint of two bases, Regulatory Activity and Designated Party, respectively. Four bases dealing with operations and facilities (Bases 5-8 in Appendix B) are used for classification in Section 4.4. Section 4.5 discusses the important classification by material types and measures as used in the regulations. Twelve bases (Bases 13-23 and 33 in Appendix B) that can be viewed as characterizing various safeguards functions are reviewed in the Section 4.6. The remaining sections deal with physical objects or locations in safeguards systems and adversaries. These discussions are given in Section 4.7 (Bases 24-29) and Section 4.8 (Bases 30-32).

4.1 REGULATORY REQUIREMENTS

The classification of the regulations in terms of their scope is a subject of some issue. A current line of thought identifies "performance-based" regulations as opposed to regulations which give specifications or define procedures.

Base 1 defines a hierarchy of three levels for the requirements: goal, performance, and procedural. As defined in Appendix B, a goal requirement gives the primary purpose or objective. A performance requirement gives an output and level of achievement required but does not describe the procedures except in a general way. Procedural requirements give the action or procedure, or perhaps specify hardware.

The use of Base 1, Regulatory Requirement, proved difficult primarily due to semantics and the alternative interpretations the regulations afford. If the regulation allows the licensee to propose decisions regarding performance and procedures, then it should be a goal requirement. If a requirement is performance oriented, then it should also implicitly address a goal. Likewise, both performance and goals should be imbedded in procedural requirements. The majority of the regulations may be classified as either performance or procedural requirements; however, it is difficult to determine a measure of performance or to define a goal beyond general terms such as "to protect" or "to control".

In order to assume "completeness" in terms of a legal requirement it is necessary that the requirement specify the intent and a means of measuring adequacy. The measure of adequacy need not be quantitative in specifying a level of performance, but rather, it may be fulfilled by interpretation of the true intent of the requirement.

Two additional bases were defined to help characterize the requirements of the regulations. They are:

- Base 4 - Safeguards Intents (specify the aims or purpose of the regulation)
- Base 12 - Safeguards Performance Criteria (characterize a level of desired performance)

These three bases may be linked together in a hierarchical fashion to characterize the regulatory requirements. This relation is depicted in Figure 4.1.

The review of the regulations along the three bases indicated some disparity in the degree of generality among the regulations. This arises because the requirement can address different aspects of the licensees' total safeguards effort. A requirement that addresses the entire safeguards effort is on the highest level of generality and is usually goal oriented. A requirement addressing some small portion is usually procedural. This problem is compounded by subparagraphs within a given section whose requirements may address different levels of generality.

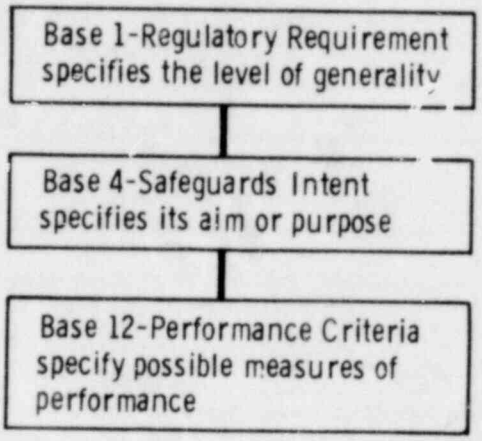

FIGURE 4.1. Bases Used to Characterize Regulatory Requirements

Figure 4.2 depicts the set of regulations that were considered to be goal oriented and seeks to identify the intents and performance measures they may specify. Sections 70.1 and 73.1 are general requirements dealing with purpose and scope of each part. The "goal" requirements of Part 70 deal with general license requirements and do not define specific safeguards intent or establish any general performance criteria.

The exemptions given in Parts 70 and 73 have also been classified as goal oriented and seeks to identify the intents and performance measures they may specify. Sections 70.1 and 73.1 are general requirements dealing with purpose and scope of each part. The "goal" requirements of Part 70 deal with general license requirements and do not define specific safeguards intent or establish any general performance criteria.
is to prevent accidents and reduce consequences. The remaining sections of Part 70 deal with general concerns such as disclaimers and authorized use of special nuclear material.

In Part 73, only Section 73.40 is classified as goal oriented beyond the general scope (73.1), interpretations (73.3), and exemptions (73.6). *The remaining majority of the safeguards regulations may be classified as either performance or procedural requirements.*

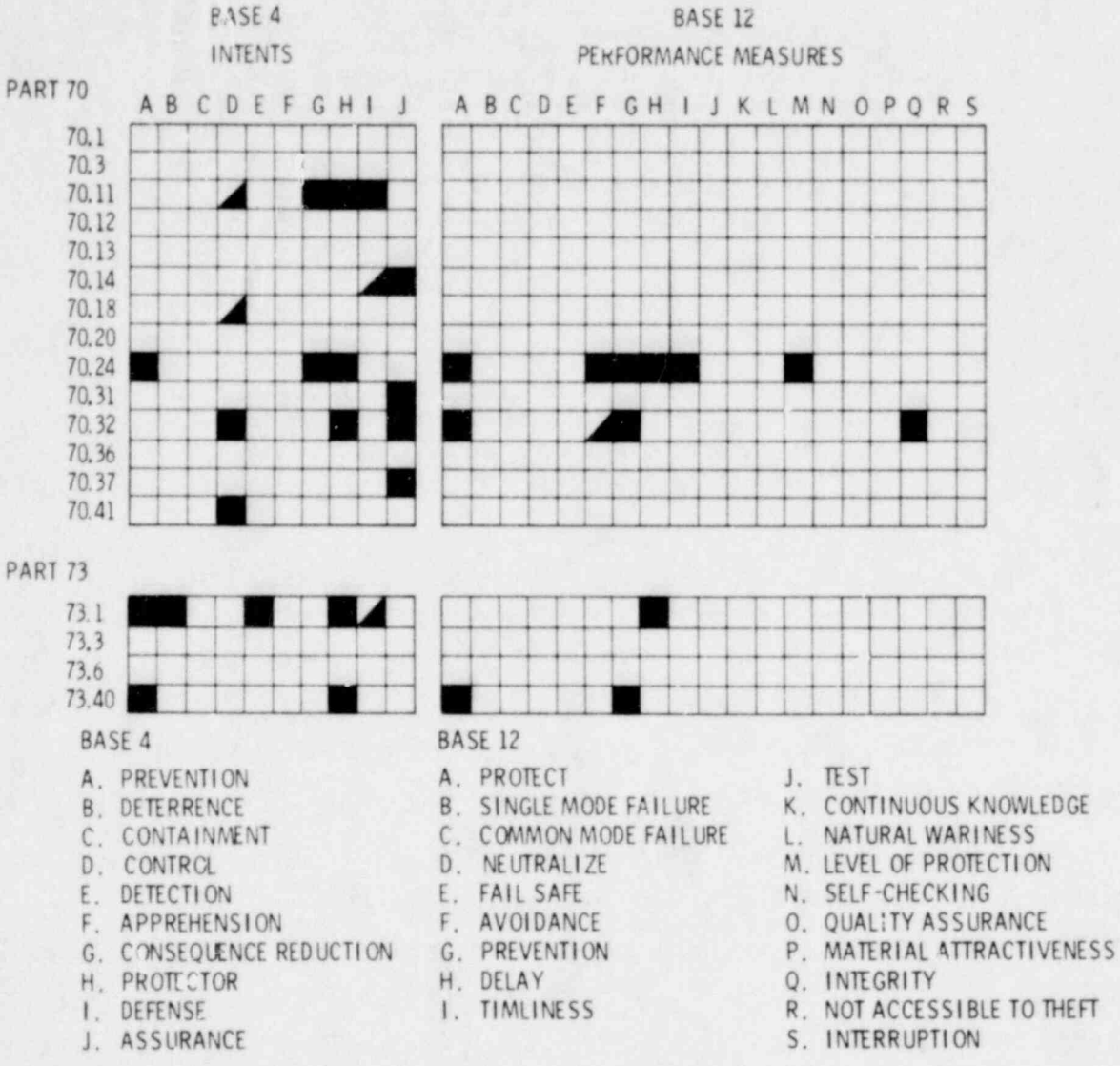

FIGURE 4.2. Set of Regulations That are Goal Oriented

The use of Bases 4 and 12 in determining intents and possible performance criteria was not particularly valuable in characterizing the content of the regulations. This is primarily because intent must be subjectively determined. Figure 4.3 depicts the classification of safeguards intents (Base 4) for the various regulations; regulations for which no clear intent in the context of Base 4 can be determined are deleted from the figure.

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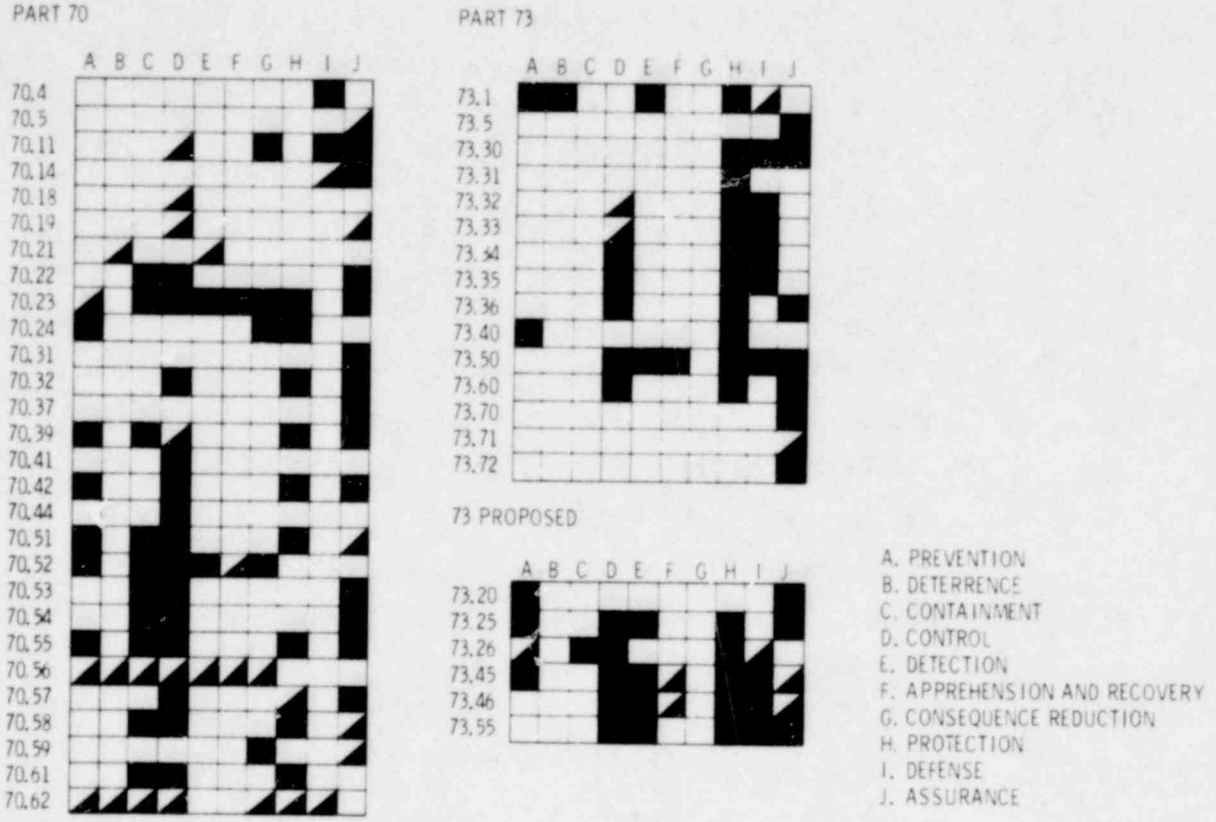

FIGURE 4.3. Safeguards Intents

The principal intents which may be subjectively determined from the regulations are prevention, containment, control, consequence reduction, protection and assurance. Of these elements, consequence reduction and assurance require a good deal of subjective interpretation. Apprehension and recovery is an element included as an intent which is not a specific portion of NRC's regulatory charter. Several of the requirements, however, can be considered to be supportive of this activity. Detection and deterrence are the other two elements not regularly appearing in the classifications. Detection is generally not singled out as a specific safeguards function but rather appears as a subpart of protection or defense. Deterrence does not regularly appear as an activity. The underlying intent structure can be elicited from the bases which characterize specific safeguards activity such as surveillance or access control.

The design of performance-based regulations is one of the concerns that Base 12, Safeguards Performance Criteria, attempts to address. The object was to identify performance criteria which could be used to develop criteria for performance-oriented regulations and then to test the current regulations for their use of these characteristics elements. No distinct pattern evolved in the classification for this base.

Base 12 lists a number of elements which might be defined as performance measures for performance or procedural regulations. They may be separated into elements related to general performance and elements related to specifications. Table 4.1 separates the two categories. The performance-related terms require explicit definition to become specifications. In general, the regulations which were classified as specification related did not provide a transition to performance. For example, the barrier requirements in Section 73.50 (b) as defined in 73.4 (f) give specifications but not in terms of performance against a definite adversary act.

TABLE 4.1. Separation of Performance Criteria in Base 12

Performance Related	Specification Related
A. Protect	B. Single mode failure
D. Neutralize	C. Common mode failure
F. Avoidance	E. Fail safe
G. Prevention	K. Continuous knowledge
H. Delay	M. Level of protection
I. Timeliness	N. Self-checking
J. Test	P. Material attractiveness
L. Natural Wariness	R. Not accessable to theft
O. Quality Assurance	
Q. Integrity	
S. Interruption	

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In summary, classification of the regulations along the lines of regulatory requirements requires:

- *Careful characterization of the intent of the regulation, including a complete set of possible intents.*
- *For "performance" oriented regulations, development of performance criteria which are measurable.*
- *Definition of a boundary between performance and procedural requirements; one possible way to separate performance and procedural requirements is by the generality of the safeguards concern it deals with.*

Classifying the regulations by their regulatory requirement identified that:

- *The intent of the regulations and possible performance criteria to measure performance should be determined.*
- *The majority of the regulations are procedural or performance oriented, but are difficult to separate.*
- *The principal intents of the regulations are to provide protection, prevention, containment, control, consequence reduction, and assurance.*
- *The activities of consequence reduction and assurance are not explicitly mentioned but many of the regulations can be interpreted as supporting these functions.*
- *Performance criteria are not provided in measurable form in the regulations but are described in general terms such as quality assurance, protect, timeliness, or providing a delay.*

4.2 REGULATORY ACTIVITY

Regulatory activity, as defined by Base 2, is those activities conducted by the Nuclear Regulatory Commission to meet the requirements of its Charter. A number of regulatory functions are listed as part of Base 2 in Appendix B. Classification of the safeguards regulations along these lines provides insight into the relationships between the regulations and the functions within the NRC's organizational structure.

For those regulations classified as dealing with one or more of the elements in Base 2, the principal activity is licensing. The majority of the regulations in Part 70 of 10 CFR deal with the process of granting a license,

including the evaluation of an application, license review, etc. The regulations dealing with licensing are treated in terms of their interactions in Chapter 5. This subsection discusses the regulations that were classified as having concern with other regulatory activities, not excluding licensing.

Figure 4.4 gives the classification for Base 2, Regulatory Activity, for those regulations which were classified as dealing with regulatory activity *in addition to* licensing. As shown in Figure 4.4, the primary activity in addition to licensing is rulemaking. For the purpose of classification, regulations which required interpretations by NRC were classified under rulemaking. Other related activities are amendments, appeals, and enforcement. The regulations dealing with the determination of exemptions were often in these categories. In 70.4 (j) a definition for research is provided. The sections of each part titled Interpretations (70.6 and 73.3) were classified as requiring guidance. The characterization of Base 2 may be summarized as follows:

- *The principal regulatory activity concern of the regulations deals with licensing. Separation of the regulations by activity does not provide significant insight into their structure.*

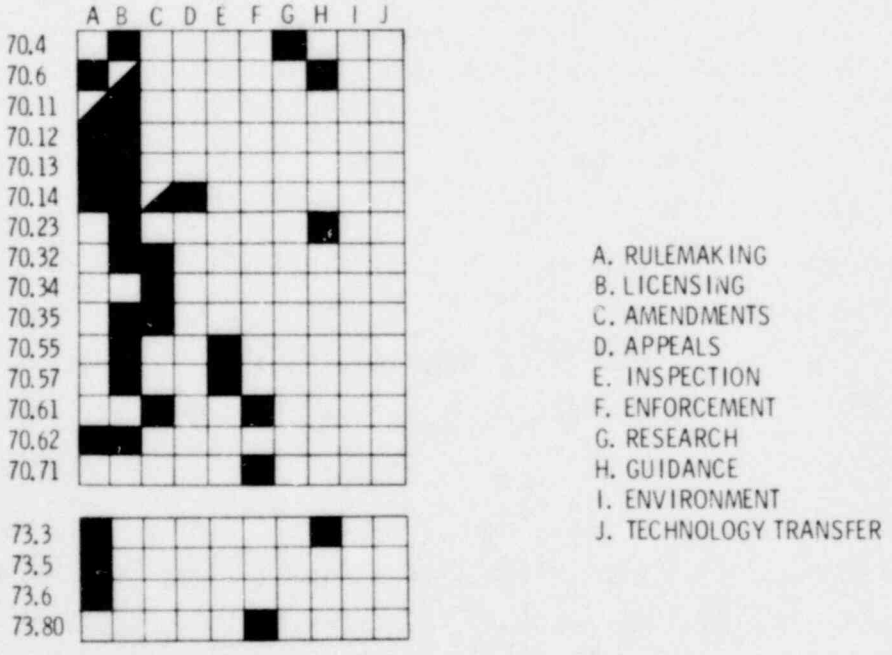

FIGURE 4.4. Regulatory Activity for Regulations Concerned with Activities in Addition to Licensing

4.3 DESIGNATED PARTY

Because the regulations promulgate legal requirements, it is often necessary to identify the responsible persons or organizations who are the object of the regulatory requirement. In addition, the regulations may identify persons who must conduct procedures spelled out in the regulations. The NRC also serves a role in certain of the regulations requiring notification, guidance, or determinations. Base 3, given in Appendix B, lists thirteen elements that are identified as potential designated parties. In the majority of the regulations the principal actors are the licensees or the NRC.

In Part 70, Special Nuclear Material, Section 70.4 provides definitions of Government Agency, Persons, United States, Agreement State, and the Nuclear Regulatory Commission. Authorized Individual, Guard, and Watchman are defined in Part 73, Section 73.2 in paragraphs (a), (b) and (c), respectively.

Almost all of the regulations contained in Parts 70 and 73 explicitly refer to the licensee as a designated party. In general, the only other persons referred to are employees of the licensee. Several exceptions are:

- In Part 70, Section 70.12 provides exemption for carriers; however, carriers are defined in Part 71, Section 71.4 (a). Carriers are also referred to elsewhere in Part 71; e.g., Section 71.55 which refers to delivery of a package to a carrier.

- Creditors, defined in Paragraph (c) of Section 70.44 are referred to only in this section.

- In Part 70, the only other persons referred to are contractors to the U.S. Government (Section 70.11) and contractors to licensees performing materials control and accounting measurements (Section 70.55 (b)). The NRC is also referred to in the majority of the regulations of this part, but not as a responsible party.

Part 73, dealing with physical protection, refers to a number of licensee employees performing protection duties. Section 73.2 defines Authorized Individuals, Guards, and Watchmen. These licensee employees are referred to in a number of the regulations of this part. Also identified but not defined explicitly are armed escorts (e.g., Shipments by Road, Section 73.31) and a designated individual who confirms shipment count or integrity (e.g., Miscellaneous Requirements 73.36(b)). Table 4.2 lists the Sections of Part 73 that explicitly refer to licensee employees.

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TABLE 4.2. Employees of Licensee Referred to in Part 73

Section		Persons
73.30	General Requirements for Physical Protection in Transit	Guards
73.31(c)	Shipment by Road	Guards, Drivers, Armed Escorts, Agents
73.32(c)	Shipment by Air (export shipments)	Authorized individual acting as escort
73.33	Shipment by Rail	Guards
73.33(c)	Shipment by Sea (exports)	Authorized individual acting ad escort
73.35	Transfers of SNM	Guards
73.36	Miscellaneous Requirements	Designated individual
73.50	Physical Protection Requirements for Licensed Activities	Security supervisor Guards, Watchmen
73.70	Records	Authorized individuals Nonemployee visitors

In the new regulations which are intended to amend Part 73, several additional persons are identified. These include armed response individual escort commander, security management individual, and member of security organization. These definitions serve to specify a structure for the safeguards organization. Sections 73.25, Performance Capabilities for Physical Protection of Strategic SNM; 73.26, Transportation Physical Protection Systems, Subsystems, Elements, Components, and Procedures; 73.46, Fixed-Site Physical Protection Systems, Subsystems, Elements, Components, and Procedures; and 73.55, Requirements for Physical Protection of Licensed Activities in Nuclear Power Reactors Against Radiological Sabotage (which are referred to in this document as part of the "proposed regulations") each refer to these licensee employees.

As it has been used, Base 3, Designated Party, does not separate the employees of the licensee as separate elements. However, these employees, moreover members of the security organization, are most commonly referenced.

Another aspect of Base 3 is the direction of the legal requirements of the regulations to a responsible party. These persons are to be held responsible if the action spelled out is not performed. In effect, this base could have two interpretations; the base may identify the set of parties receiving a "command", and the set having legal liability. For example, Section 73.35 requires that all transfers of SNM be monitored by a guard. The guard is the command target since he must perform the function, i.e., monitor transfer of SNM. The licensee is the liability target since he will be held responsible in the event of noncompliance.

In Part 70 the licensee is the object of the requirement in terms of both responsibility and liability. This is because this part does not single out individuals within the licensee's organization as functionaries. In the regulations dealing with physical protection this separation is usually made. However, the regulations are fairly explicit about liability (e.g., "the licensee shall provide assurance that ... .") and less explicit about who must conduct the activity. The characterization of the regulations by designated parties may be summarized by the following observations.

- *Licensees are the principal persons designated by the safeguards regulations; only for physical protection requirements are licensee employees singled out for performing functions.*
- *The "proposed regulations" in Part 73 specify a number of members of the security organization differently than in the current regulations. (e.g., armed response individual vs. guard).*
- *A separation between liability and function performance for designated parties would improve consistency between Part 73 which provides the separation and Part 70 which does not.*

4.4 OPERATIONS AND FACILITIES

Four bases were defined to characterize the content of the safeguards regulations with respect to operations or facilities:

- Base 5 - Facility Type
- Base 6 - Fixed-Site Operations
- Base 7 - Transit
- Base 8 - Time Phase of Facility

As indicated in Appendix A, the regulations may be divided into 1) those for SNM in transit; 2) those for SNM at fixed sites; and 3) those for fixed sites themselves. Base 7 corresponds to the first of the above divisions. Base 6 lists a number of operations that may be singled out for specific requirements at fixed sites; this base provides a set of subcategories for the facilities listed in Base 5. These latter two bases deal with classification for the other two divisions above. Base 8 deals with temporal aspects at facilities.

The kinds of facilities in which SNM is used or the application of SNM for which the rules are intended are not coupled well with the individual sections of each part of the safeguards regulations. To some extent, the specific facilities or operations can be inferred from the exemptions spelled out in the regulations. In other cases, the inference can be drawn from a knowledge of the operations involved in a given kind of facility or the type and quantity of material used in a given application.

This subsection first classifies the regulations in terms of transit operations. Then, facilities and operations spelled out by the regulations are addressed. The interactions of the regulations dealing with operations and facilities are discussed in Chapter 5.

Transit Operations

Figure 4.5 gives the classifications for Base 7, Transit. As shown in the figure, the majority of the regulations in Part 70 are marked as dealing with transit in an implied manner. Although not shown in Figure 4.5, Section 70.1 indicates the purpose of Part 70 to include licensing to receive title to, deliver, receive, transfer, import and export SNM. Hence this part is also concerned with transit activities. The only sections of Part 70 explicitly mentioning one of the transit elements are shown in the figure. In Section 70.22(g) trucks are indicated for road transport whereas paragraph (c) of the same part deals with export. Transfers are explicitly mentioned in 70.39 to 70.42, 70.51, 70.54, 70.55 and 70.58. Two of these sections also refer to import-export as shown in the figure. The key sections dealing with licensing and transit are: exemptions (70.11 and 70.12), content of license applications (70.22 and 70.32) and controls and accounting for shipments (70.57 and 70.58).

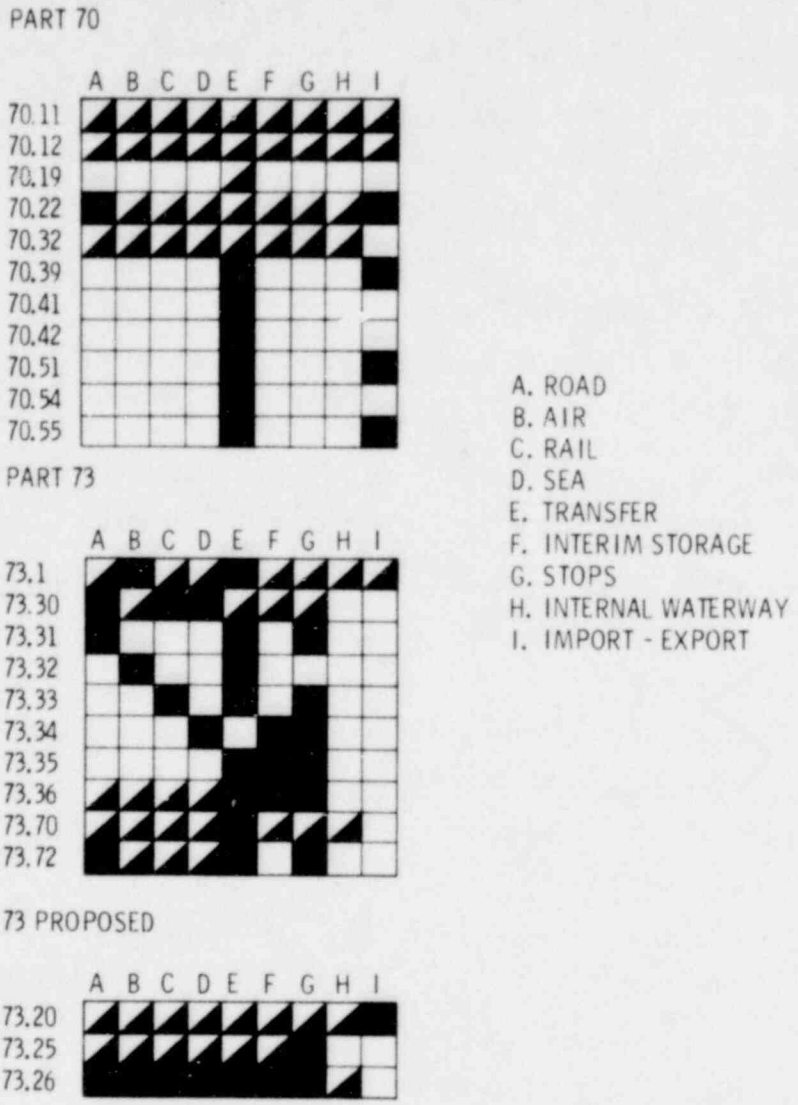

FIGURE 4.5. Regulations Classified for Transit

In Part 73, protection requirements for shipping operations are covered. Section 73.1, Purpose and Scope, identifies transfers and shipments by air explicitly. Parts 73.30 to 73.36 deal with transit protection requirements in detail. The concerns of this part are shown in Figure 4.5. Records and notification requirements are also addressed in this part.

Facilities and Operations

The facility types and operations are more difficult to deal with in classifying the safeguards regulations. The kinds of facilities that Parts 70

and 73 regulate, except for Section 73.55, Requirements for Physical Protection of Licensed Activities in Nuclear Power Reactors ..., are:

- UO_2 Processing Plants
- PuO_2 Processing Plants
- Fuel Reprocessing Plants
- Enrichment Plants
- Medical and Research Reactors
- Scrap Recovery
- Waste Disposal.

Base 5, Facility Type (listed in Appendix B) defines eight general types of facilities which come under the requirements of the regulations.

Essentially, the types of facilities and operations are determined by the material types and quantities and process operations they contain. In Section 70.4, in a footnote to Paragraph (h) defining "persons", facilities governed by the regulations are listed. A number of other sections also refer to facilities. Section 70.21, License Applications, lists fuel production and fabrication (Base 7, element C), scrap conversion, and waste disposal as requiring environmental consideration. Research and development activities are defined as a footnote to Section 70.23. The description most commonly used for facilities is "production and utilization facilities."

Classification of the regulations within Base 6, Fixed-Site Operations, fared no better than by Facilities. The sixth base lists a number of operations from mining to final storage which may occur in the nuclear fuel cycle. Definitions for the twenty elements of the base are given in Appendix B. Of the elements, only fuel fabrication, scrap recovery, and power production are referenced in the regulations. Although, except for mining and milling, the regulations cover all the processes or activities listed by this base, the regulations are not organized by operations.

Another possible category for consideration in this context is the use or application of the nuclear material. Beyond the applications of power production or research, the regulations mention calibration and reference sources and other sealed sources. Again, the regulations are oriented to the kinds and amounts of material used in the application.

Base 8, Time Phase of Facility, considers the temporal aspects of facilities or transit operations. Eleven stages from planning to decommissioning are listed as elements of this base. Two abnormal situations (threat or alarm mode, and criticalities) are also listed in this base. It would seem reasonable that the licensing and operation process covered by the regulations would account for a number of temporal aspects.

Section 70.4, paragraph (5) defines the term "Commencement of Construction". It is used in Section 70.23 to indicate that a determination of environmental impact must be made before this stage of activity, and is the only temporal definition in the regulations. With the exception of the above, the regulations can be separated as either "prior to operations" or "in operation." Although several of the physical protection requirements in Part 73 deal with threat or alarm situations, the majority of temporal considerations are part of the licensing process.

The licensing process entails planning, design, site approval, and hearings. In the regulations, Parts 70 and 73 considered in this study spell out the requirements for the planning and design which must be documented for license approval. The requirements must also be considered during normal operations to ensure compliance. No time scales or stages of activities are outlined in the regulations as part of the licensing process, except for the above environmental requirements.

Once an applicant becomes a licensee, the meaning of the regulations changes from approval to compliance. This, in effect, means that the licensee conducts activities as planned and approved, subject to any new requirements. Normal operations in terms of activities are treated in other bases such as Access Control (Base 13) or Accounting (Base 23). Abnormal operations, such as duress alarms or natural events, are also considered in other bases, (e.g., Response (Base 16) or Investigation (Base 15)). Only in the areas of material accounting and records and reports are time intervals specified. It would be up to the licensee to specify as part of his planning process, the sequence he would follow in conduct of his various activities.

The organization of the regulations in reference to facilities and transit operations can be characterized as:

- *For transit operations, the physical protection requirements of Part 73 are organized by mode or activity as specified in Base 7, Transit, listed in Appendix B.*

- *For facilities, the regulations deal with material kinds and amounts; the types of facilities must be discerned by the exemptions or engineering knowledge of the operations.*

- *Organization by processes in facilities is a finer level of detail than treated in the general requirements of the regulations.*

- *Temporal aspects of the regulations may be separated into the licensing process or compliance during operation; the regulations, with the exception of accounting and reporting intervals do not define times for stages or activities.*

- *Organization of the regulations from the viewpoint of the kinds of facilities, operations, or temporal aspects of activities would be possible but only transit requirements are currently organized in this manner.*

4.5 MATERIAL TYPES AND MEASURES

The regulations concerned with safeguards impose various levels of control via their requirements, dependent upon the quantity and kind of material which the licensee possesses or is authorized to possess. The principal material of concern is special nuclear material (SNM). The changes in the levels of control, in general, appear at five points:

- any amount
- one gram
- three hundred fifty grams ^{235}U/200 grams Pu
- one effective kilogram as defined in Section 70.4(t)
- five thousand grams as defined in Section 73.1(b)(1).

Insofar as kinds of SNM considered, a distinction is often made between low-enriched uranium (<20% ^{235}U) and high-enriched uranium (20% or greater ^{235}U). Also, SNM not separated from highly radioactive materials such as irradiated fuels is treated as a "special form" material.

Three bases were developed to organize and classify the regulations by material types and measures:

- Base 9 - Material Type Classification
- Base 10 - Elemental Form
- Base 11 - Material Measures

Base 9 defines the terms which are used to classify material based upon its constituents or having a specific application or use. This base is intimately linked with Bases 10 and 11 because definition of material types is dependent on the form and amount of their constituents.

The principal material of concern is SNM. The regulations in Parts 70 and 73 are concerned with the licensing of this material which is sometimes also referred to as fissile material or strategic special nuclear material. Other material designations are by-product material, waste or scrap, and fertile material. Terms related to processes are also listed as elements in this base, including ultimate product, material in process, unopened receipts, and sealed sources.

Base 11 deals with the various material measures used in the regulations. The principal measures are weight, enrichment, effective kilograms, and formula quantities. These measures are extensively used to indicate a requirement's scope or level of control in Parts 70 and 73.

Figure 4.6 depicts the various material measures explicitly referred to in the regulations. Note that all the regulations are listed in the figure; there are only a few regulations that do not identify a specific material type. As mentioned, the regulations of Parts 70 and 73 refer primarily to SNM. The regulations of Part 71 refer to fissile material and the new sections of Part 73 specify strategic SNM. The distinction between SNM and fissile material is not great and in a sense indicates an inconsistency in terminology. Strategic SNM is distinguished by its formula quantity but the term "strategic" is notably absent from the current regulations.

The classifications developed from the regulations for Base 11, Material Measures, are given in Figure 4.7. It is interesting to compare Figures 4.6 and 4.7; material types are often referred to without associated measures.

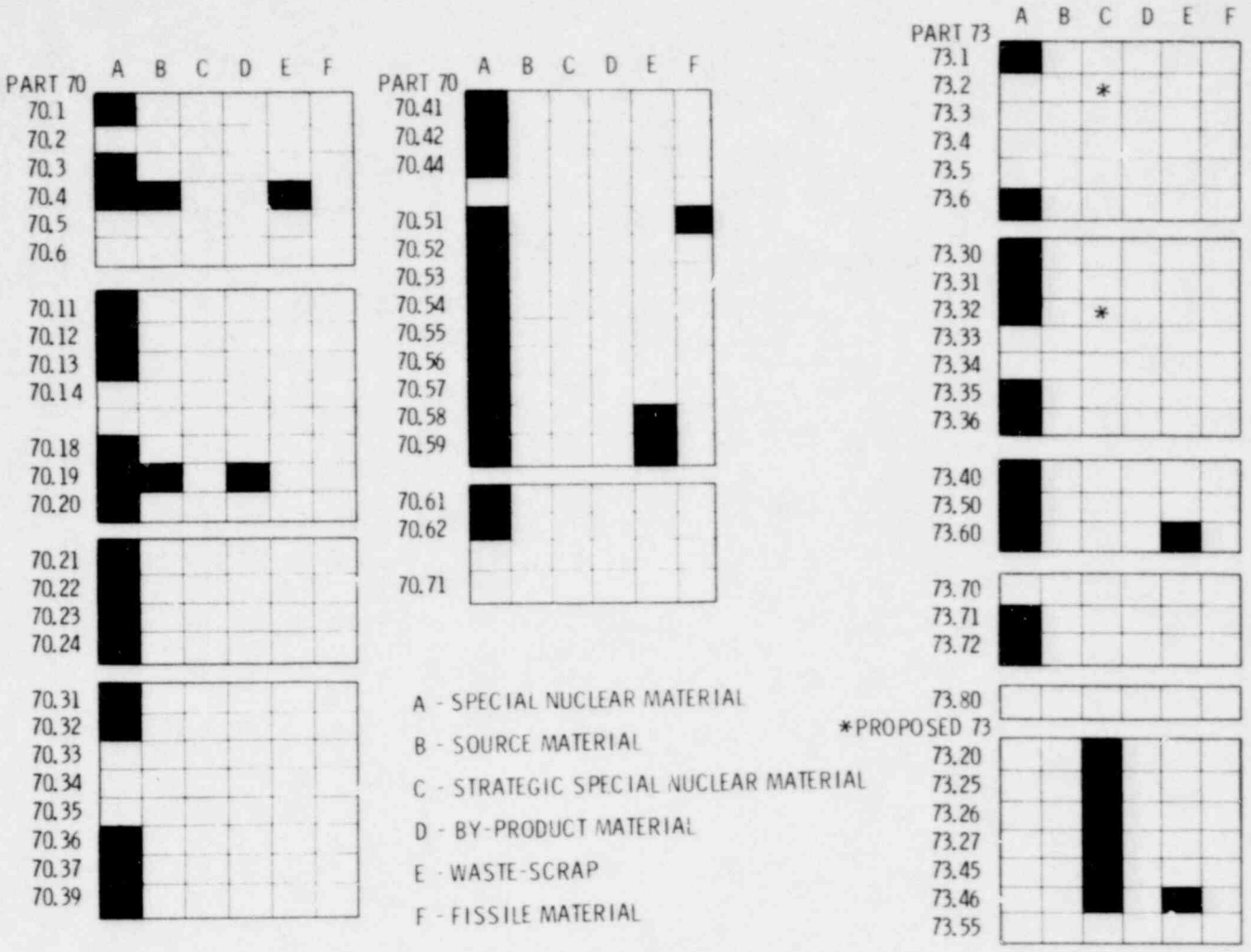

FIGURE 4.6. Regulations Explicitly Referring to Material Type Classification

In some of the sections, the material amounts are implicit from the context. Also note, however, that the review has taken place at the section level. In a number of the regulations, several of the paragraphs identify requirements for differing quantities, based on alternative measures for the material.

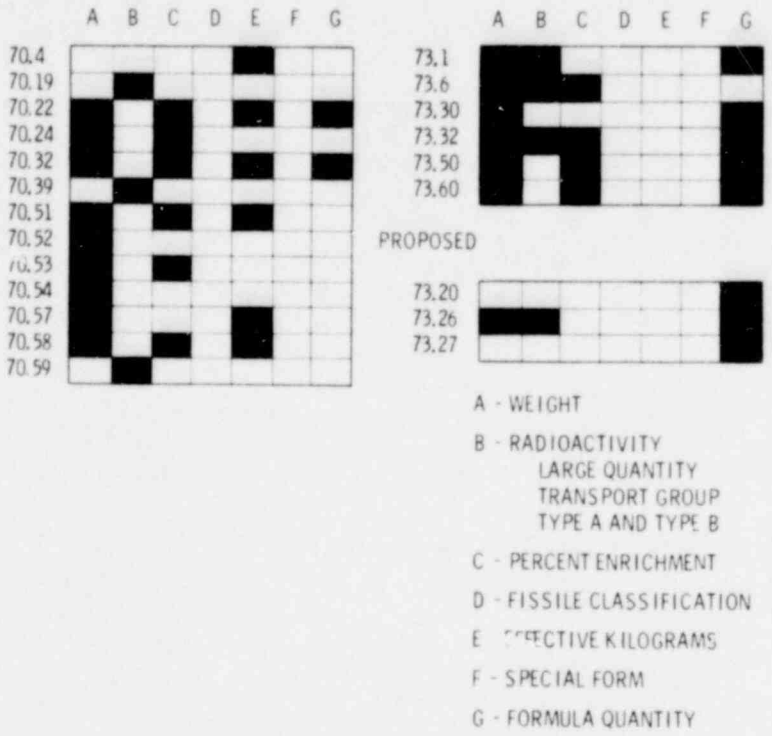

FIGURE 4.7. Regulations Explicitly Referring to Material Measures

Focusing the discussion here on the individual sections depicted in Figures 4.6 and 4.7 would be unnecessarily detailed. It is important to point out that the five levels of control listed in the first paragraph of this subsection are not the only categories appearing in the regulations. The principal material measure used by the regulations is weight, in grams or kilograms. Table 4.3 lists the various weights listed in the regulations.

TABLE 4.3. Material Amounts Specified by Weight

Weight, grams	Material Type	Enrichment	Description	Reference
<9,000 g	U-235	Low < 20%	Maximum limit of error on MUF	70.51(e)(5), 70.53(b)
≥formula quantity (5,000 g)	U-233, U-235, Pu	U-235 ≥ 20%	Definition physical security plan requirements	73.2(u)(proposed) 70.22(h)
			Physical protection scope	73.1(b)(c)
			General performance requirements for protection	73.20(a)(proposed)
			Physical protection in transit	73.30(a)
			Physical protection for licensed activities	73.50
			Physical protection at fixed sites	73.60
			Advance notice of shipment	73.72
<2,500 g	Pu 238, 239, 241 in Pu-Be source		Limitation quantity for Fissile Class III shipment	71.11(a)(2)
>1,500 g	U-235	4% by weight	Criticality accident requirements	70.24(a)
≥1 effective kg.	U-233, Pu		Definition	70.4
	U-233	≥ 1%	Description of material control and accounting program	70.22(b)
	U-233	< 1%	Program for material control and accounting	70.32(c)
	U-depleted	< 0.5%	Requirements for material control and accounting	70.51(c)
	Thorium		Procedures for material control and accounting	70.51(d)(e)
			Measurement control program	70.57(b)
			Procedures for material control	70.58(a)
≥1 effective kg.	Pu, U-233, U-235	> 80% Pu-238 > 20% U-235	Inventory interval ea 2 months	70.32(e)
≥1 effective kg.	Pu, U-233, U-235	> 80% Pu-238 < 20% U-235	Inventory interval ea 6 months	70.32(e)
<800 g	U-235 in homogeneous hydrogenous soln.	< 1% wt U-235 atomic ratio Hydrogen > 5,200	Exemptions from packaging requirements	71.7(b) 71.9(d)
>700 g	U-235		Criticality accident requirements	70.24(a)
>520 g	U-233		Criticality accident requirements	70.24(a)
<500 g	U-235		Limitation quantity for Fissile Class III shipment	71.11(a)(2)

TABLE 4.3. Material Amounts Specified by Weight (Cont'd)

Weight, grams	Material Type	Enrichment	Description	Reference
< 500 g	Homogeneous Hydrogenous soln: Fissile material	Atomic ratio H_2 > 7,600	Exemptions from packaging reqirements	71.7(b)
	U-233, U-235, Pu	< 1% Pu to U-233 and U-235 Atomic ratio H_2 > 5,200		71.9(d)
< 450 g	Pu-any combination U-233,U-235		Criticality accident requirements	70.24(a)
< 400 g	Pu-238, 239, 241 in Pu-Be Source		Maximum Single package quantity	71.11(a)(2)
> 350 g	U-235, U-233, Pu any combination		Inventory interval at least 12 months material status report	70.51(d) 70.53(a)
< 350 g	Fissile material		Exemption for packaging	71.7(b)(5)
< 350 g	U-235	U-235 < 20%	Air shipments (passenger craft) max.	73.1(b)(3) 73.32(a)
< 300 g	U-233, Pu-238, 239, 241		Maximum quantity for Fissile Class III shipment	71.11(a)(2)
< 300 g	High enriched U or U-235	< 20%	Maximum limit of error on MUF	70.51(e)(5), 70.53(b)
< 200 g	Pu or U-233		Maximum limit of error on MUF	70.51(e)(5), 70.53(b)
> 200 g	SSSM by formula quantity		Log requirements for shipments	73.26(b)(3)
> 50 g	U-235, U-233, Pu		Investigate shipper-receiver differences	70.58(g)
< 20 g	Pu or U-233		Maximum quantity for passenger air shipment	73.1(b), 73.32(a)
> 10 g	U-235, U-233, Pu		Measurement system for transfers	70.58(e)
< 15 g	Fissile material		Exemption for package requirements	71.9(a)
≥ 1 g	U-235, U-233, Pu		Reports of accidental criticality, loss, theft	70.52, 70.54

As shown in Table 4.3, numerous weight categories are used in the various paragraphs or sections of the regulations. The key levels shown in the table are 5000 grams (formula) and 1 effective kilogram. The table also lists the enrichment category for the isotopes of uranium or plutonium where specified.

In general, the measurements used to specify material quantities are not used inconsistently in the regulations. The material control and accounting requirements were, in general, specified for smaller quantities than the physical protection requirements. The material quantity specifications, however, can also be associated with facilities in an interesting manner. In this context several apparent inconsistencies may appear. This is treated in Chapter 5 of this report.

Classification of the regulations in terms of material types and measures can be described as:

- *The principal material type of concern is SNM in Part 70 and strategic SNM in Part 73. Material measures are principally by weight in grams.*
- *A number of the regulations refer to material types without specifying quantities. Quantities, where defined, cover a wide spectrum rather than being based on only several levels of amount.*
- *For general safeguards concerns five weight levels are used to define "control" and can be discerned in the regulations.*

4.6 SAFEGUARDS SYSTEM FUNCTIONS

Twelve bases were defined to characterize the various functions that occur in the safeguarding of facilities and transit activities. A major organization in the regulations separates 1) materials control and accounting and 2) physical protection. Here, the techniques of material control and accounting or physical protection are grouped together and then decomposed by the functions that people conduct to carry out the requirements.

The twelve bases describing safeguards functions are:

Base 13 - Access Control
Base 14 - Surveillance
Base 15 - Investigation
Base 16 - Response
Base 17 - Planning-Design

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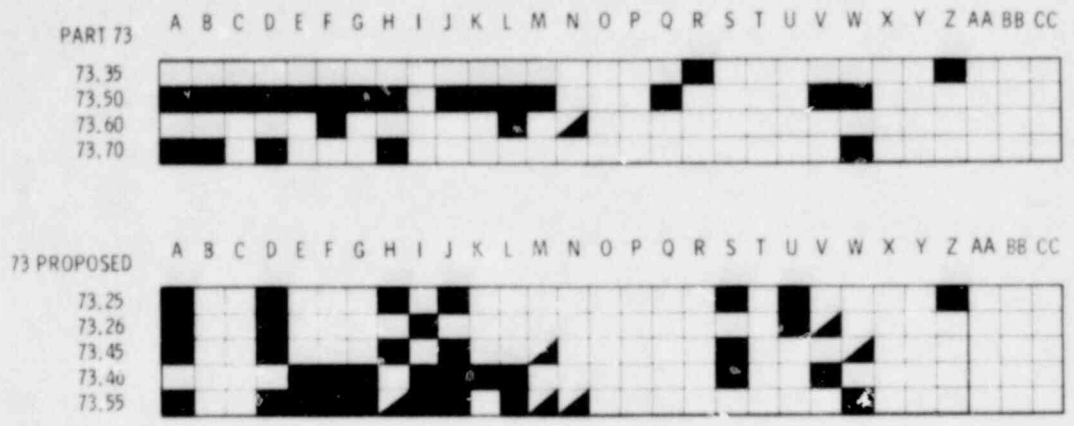
Base 18 - Records and Reports
Base 19 - Deterrence
Base 20 - Assurance
Base 21 - Communications
Base 22 - Security Organization
Base 23 - Accounting
Base 3[illegible] - Consequence Reduction.

Most of the regulations classified as dealing with safeguards functions are listed in Parts 70 and 73. The functions of access control and response are limited to the physical protection regulations of Part 73. The accounting function is primarily contained in Part 70 of 10 CFR.

Base 13 - Access Control, is designed to categorize the monitoring and enabling of authorized movement of personnel, vehicles, and packages entering and exiting security areas. The twenty-nine elements of this base are listed and defined in Appendix B. The elements deal with procedures for identification and authorization for items and personnel, search activities, securing access, and so forth. Figure 4.8 gives the classification of the regulations that were identified as dealing with access control.

The function of access control is confined exclusively to the regulations in Part 73. The regulations in Sections 73.35, 73.25 and 73.26 deal with access control during transit operations. The remaining regulations shown in Figure 4.8 deal with access control at fixed sites. It is important to note from the figure several of the items that are not marked. For example, although several of the regulations indicate the use of authorization criteria (element H) to gain access, none indicate how to establish such authorization (element AA not marked). Identification is required for access and is mentioned in several of the sections, however, methods for identification such as badges (element I), authorization criteria (element H), vouching (element P) and confirmation (element M) are not consistently coupled with the process. Part 11 of Chapter 10 CFR addresses a number of the aspects of access authorization but is not referenced by Parts 70 or 73.



A. IDENTIFICATION
B. VISITORS
C. EMPLOYEE PROCEDURES
D. IDENTIFICATION INFORMATION
E. SEARCH, PERSONNEL
F. SEARCH, PACKAGES
G. PERSONNEL ESCORT
H. AUTHORIZATION CRITERIA
I. BADGE DISPLAY
J. VEHICLE ACCESS
K. VEHICLE EXCLUSION
L. VEHICLE SEARCHES
M. CONFIRMATION
N. DOORWAY MONITORS
O. DOOR LOCKING, INTERLOCKING
P. VOUCHED FOR
Q. CONTINUOUSLY MANNED
R. CLOTHING CHANGE
S. TEMPORAL, SCHEDULING, TIME LIMIT.
T. NUDE WALK THROUGH
U. ISOLATION
V. PERSONNEL DUTIES
W. ACCESS REGISTRATION
X. PROHIBIT STOPS
Y. SAFE HAVEN
Z. TRANSIT STORAGE, INTERIM
AA. ACCESS AUTHORIZATION
BB. CLOSED-LOOP CONTROL
CC. CONTRABAND

FIGURE 4.8. Access Control

Sections 73.50, 73.45, 73.46, and 73.55 deal primarily with the major access control concerns. Section 73.60 treats searches whereas 73.70 deals with access registrations. The reader should focus on the contents of Section 73.50 for the general requirements for access control. The other requirements serve to qualify and elaborate on its requirements.

Base 14 - Surveillance is viewed here as activities related to the observation of personnel and or material for the purpose of detection of unauthorized activities. It includes the patrol functions as well as monitoring of people as separate from monitoring of processes for purposes of material accounting. The key functions within surveillance are patrols, seal checks, and procedures.

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Figure 4.9 displays the regulations which may be classified as dealing with surveillance. As can be seen, monitoring is primarily specified as periodic, and is concerned with seal or vault checks. The regulations in Part 70 deal with monitoring of facilities and materials. In Part 73, the various transit operations are marked primarily as having surveillance requirements. Only Sections 73.50, 73.60, 73.45, 73.46, and 73.55 deal with surveillance at fixed sites. A general observation is that surveillance at fixed sites is not separated as a unique activity in the requirements. The licensee, in his security plan, must provide the detail on how he will conduct his patrols and surveillance. This activity is supportive of either material control or protection but is not strongly coupled in the regulations.

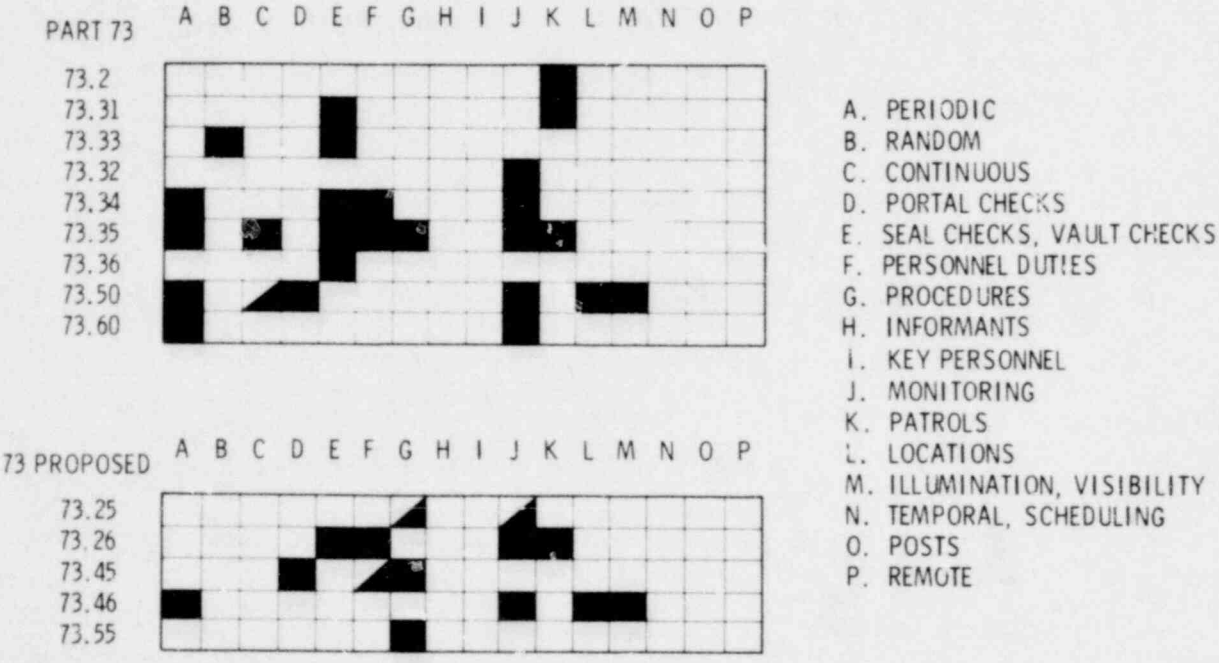

FIGURE 4.9. Regulations Dealing with Surveillance

Base 15 - Investigation. If a sequence were considered in the safeguards functions, surveillance could be viewed as providing detection; the detection would logically be followed by an investigation of the detected activity. Investigation, as used in Base 15, is the inquiry into events which would

potentially compromise the safeguards system's overall function. Investigation can be a detailed long-term process, such as security clearances which assess the possibility of an event, or it can be a quick assessment of a situation which may require a report or an alarm. The key elements in this base are events. Base 15 lists five kinds of events requiring investigation. Investigation also includes the gathering of sufficient information to determine the significance of a given event.

The classification for the investigation base is given in Figure 4.10. As shown, the regulations treat investigation as primarily a physical protection function. Similar to the surveillance function, investigation is not treated as a function by the regulations. Hence, it may be interpreted that the regulations tacitly assume investigation will normally occur in conjunction with the identification of certain events. The sequence from surveillance and investigation to response is not actually characterized by the regulations.

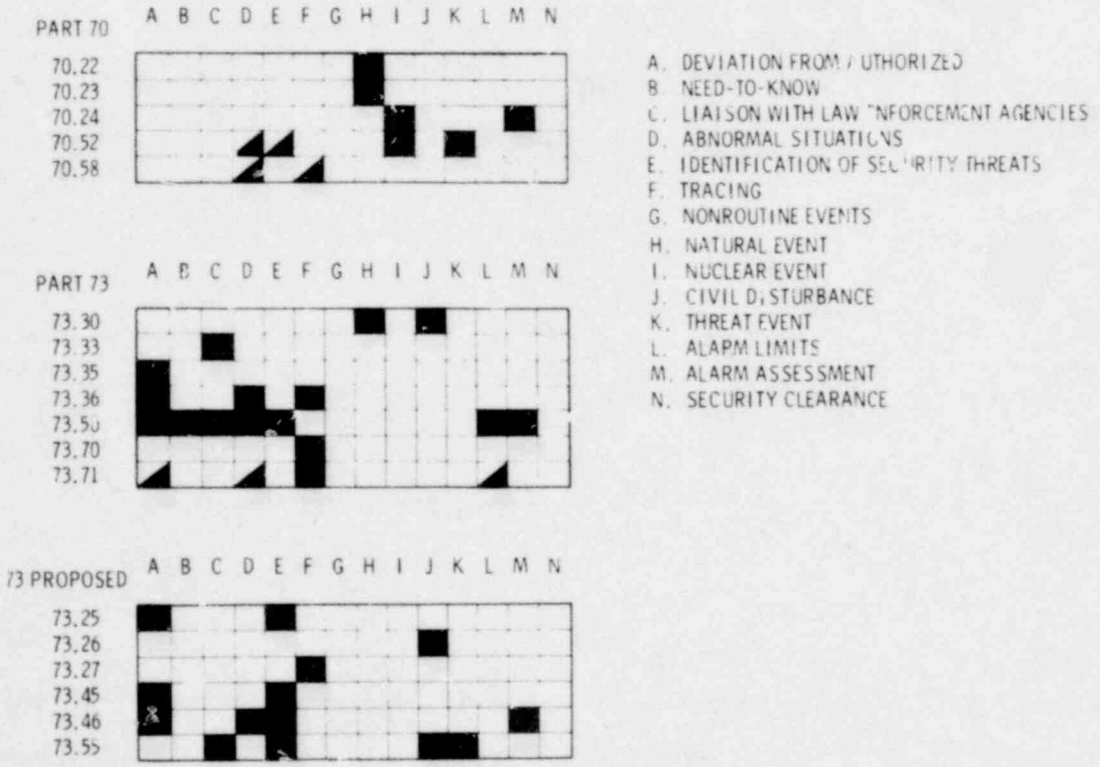

FIGURE 4.10. Investigation

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The response function is the third function described in the above sequence. Again, this function is part of the protection activity. The new regulations, intended to augment Part 73, deal with the majority of response activities. For the protection of fixed sites, response is limited to the environs of the facility. The scope of the regulations do not include arrests of perpetrators or hot pursuit. These elements are not marked in the regulations dealing with response shown in Figure 4.11.

FIGURE 4.11. Response

In Base 16 - Response, events are separated into contingency and threat events. A sequence of actions is included in the elements selected for this base. First, response requires pre-established procedures or tactics in dealing with a threat. The regulations do not delineate this element in their requirement. Another a priori activity is the liason with other agencies for the purpose of response: liason is treated in Section 73.33 for transit operations and in Sections 73.50, 73.46 and 73.55 for fixed sites. Next, either threat or contingency events (e.g., possible threats or events which compromise safeguards) must be assessed. These are given as elements K and L, respectively, in Base 16. This assessment is assumed here to be subsequent to investigation and requires determination of possible consequences to set a desired level of response. The new performance-related regulations (Sections 73.46 and 73.55) deal with this aspect. Element F in Base 16 describes the force level that must be determined.

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The next step, assuming an active response is required, should be to call assistance (element D) or issue a warning to possible adversaries (element B). Calling for assistance is coupled with liason in Sections 73.50 and 73.46. The act of warnings is not part of the requirements. Elements A - Response to Threat Events, and I - Response to Contingencies, are the next stage of a possible response sequence. For example, a response to a contingency may only require the resealing of a vault that was left open. Contingencies do not imply the presence of adversaries or an act in progress. Security threats imply the presence of adversaries or an act in progress. The regulations are primarily concerned with acts in progress. Pursuit and arrest are left to other agencies and not covered in the regulations. The new regulations in Part 73 threat the response function in a more organized manner than those currently in place.

Base 17 - Planning and Design. The licensing process requires a number of a priori activities for the operation of a safeguards system. These activities are grouped as part of the planning-design function characterized as Base 17. The major regulations dealing with planning for physical security are in Sections 70.22, 70.23 and 70.32 in Part 70 dealing with license application and the contents of the applications defined in Sections 73.50, 73.60, 73.[illegible], 73.46 and 73.55 in Part 73. However, the majority of the regulations have requirements that are related in some manner to the planning or design process.

In Part 70, design features are considered in Section 70.39 for the construction of calibration and reference sources, in Section 70.57 for the measurement control program, and Section 70.59 for effluent monitoring. Element B, Design Bases for Physical Protection, of Base 17, is a concern of the new physical protection regulations. Figure 4.12 depicts the list structures for regulations classified as concerned with the various elements of the planning and design function.

Planning and design of physical security systems and procedures are not addressed in terms of procedural requirements as defined in Base 1 and discussed in Section 4.2 above. As shown in Figure 4.12 very few of the regulations deal with surveillance design (element H), or contingencies (element I), responsibilities (element Q) or special temporary procedures (element T). The

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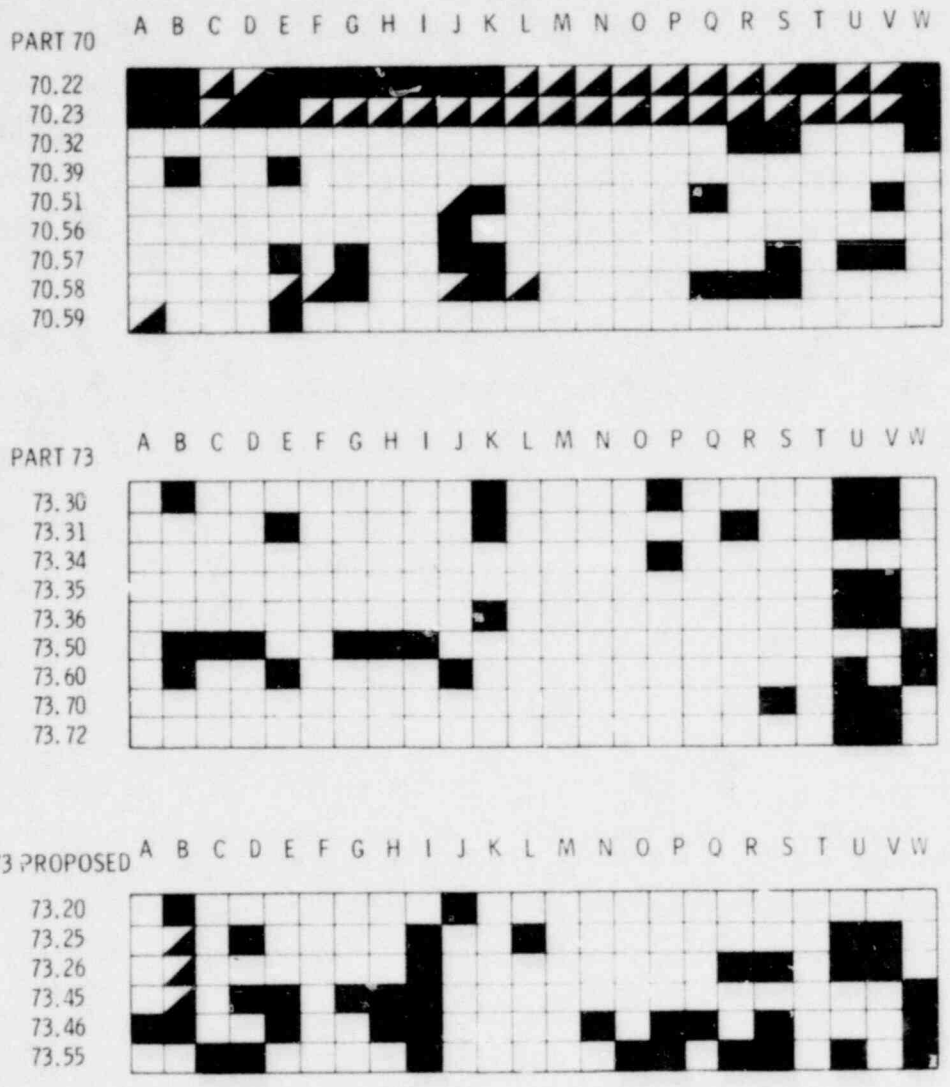

A. DESIGN BASIS INCIDENT
B. DESIGN BASES FOR PHYSICAL PROTECTION
C. PLANT ISOLATION
D. SECURITY AREA ISOLATION
E. DESIGN FEATURES
F. DESIGN RELATIONSHIPS
G. EQUIPMENT
H. SURVEILLANCE DESIGN
I. EMERGENCIES, CONTINGENCIES
J. TEST CONTROL
K. HANDLING, STORAGE, SHIPPING
L. NONCONFORMING MATERIALS PARTS, OR COMPONENTS
M. BADGE SYSTEM
N. WEAPONS
O. SECURITY EQUIPMENT
P. KEYS, LOCKS, COMBINATIONS
Q. RESPONSIBILITIES
R. ARRANGEMENTS FOR ASSISTANCE
S. SECURITY PLAN CHANGES
T. SPECIAL TEMPORARY PROCEDURES
U. SCHEDULES
V. SHIPPING PLANS
W. PHYSICAL SECURITY PLAN

FIGURE 4.12. Planning and Design

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licensee is left to his own devices in the development of physical security plans. However, a proposed appendix to Part 73 (Appendix C Licensee Safeguards Contingency Plan-43 FR11962) establishes a set of criteria for such a plan. The information contained in Regulatory Guide 5.51 and the regulations themselves can be treated as minimum constraints rather than as outlining procedures to follow in establishing physical security.

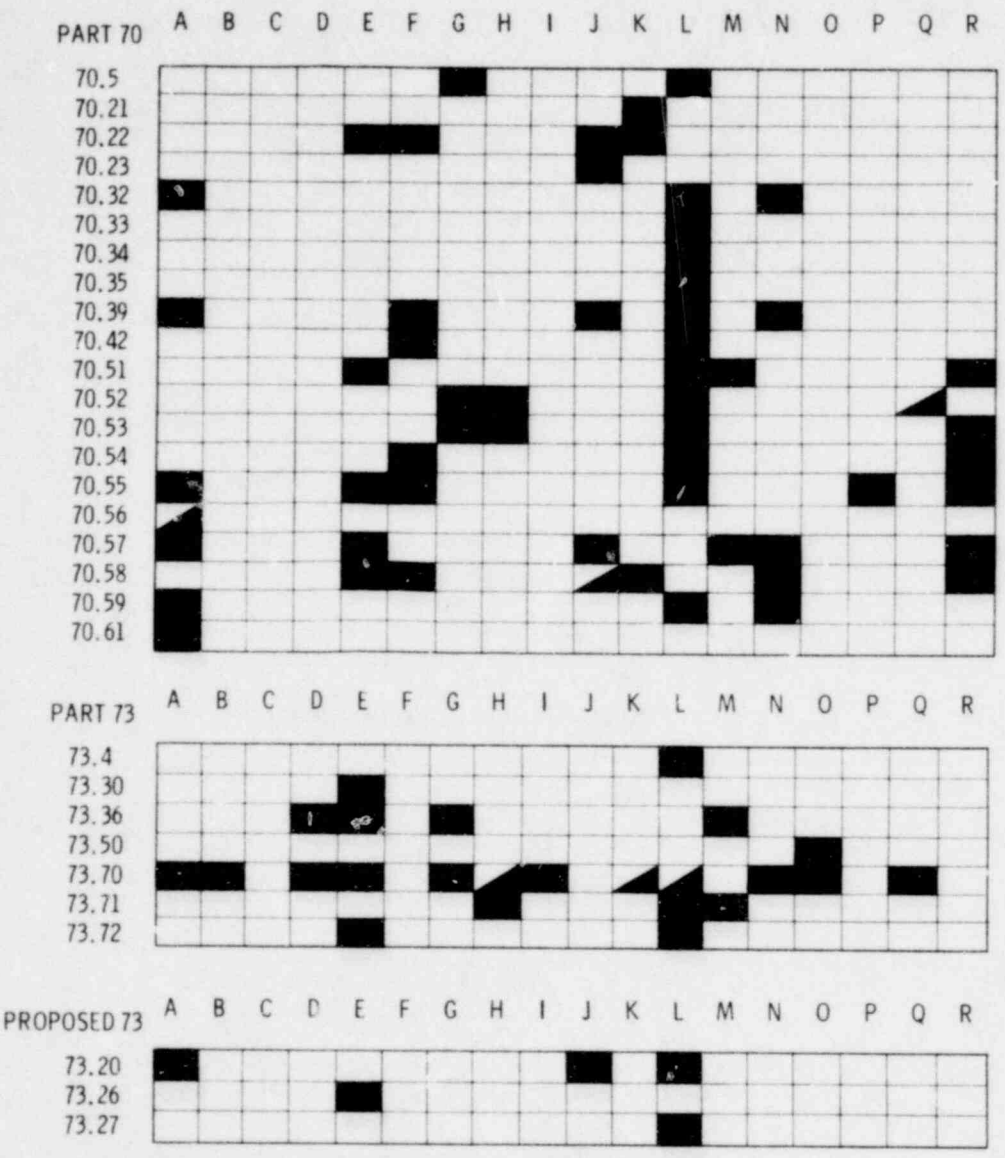
Base 18 - Records and Reports. The majority of the safeguards activities require recordkeeping and reports to the NRC for compliance with requirements. This base enumerates the kinds of reports or records that the licensee can be expected to keep in the normal conduct of activity or as a result of some abnormal occurrence. The classification of the regulations in terms of this base is given in Figure 4.13.

In the figure, it is shown that the regulations can be interpreted as requiring some form of records or reports for all the elements listed except for surveillance (element C). It is assumed that if any surveillance activity results in a detection, then reports are required.

Note that Base 18 is concerned with documentation of activities and does not include communication (which is addressed as base 21). The two functions can be separated by the distinction that certain communications may require records or reports but not vice versa.

The records and reporting requirements are interspersed throughout the various regulations. Sections 73.70 through 73.72 of Part 73 are titled as having this exclusive concern. These sections, as shown in Figure 4.13, do indeed cover a number of recordkeeping or reporting requirements for physical protection activities. A majority of activities must be reported to the NRC or are subject to their audit. Those regulations that explicitly refer to reports to NRC have element L marked in the figure. As shown, the majority of the regulations mention the NRC as the recipient of the report.

Base 19 - Deterrence. Deterrence is a safeguards function that serves to discourage or cause potential adversaries to refrain from or voluntarily halt a sequence designed to obtain or misuse nuclear material. It would seem that the successful application of this function as an intent of the regulations



A. TESTS AND INSPECTIONS
B. REPSONSE
C. SURVEILLANCE
D. ACCESS CONTROL
E. SHIPPING RECORDS
F. DESCRIPTION OF NUCLEAR MATERIAL
G. COMMUNICATIONS
H. VIOLATIONS, INFRACTIONS, INCIDENTS
I. PERSONNEL
J. DESIGN PLANS
K. DOCUMENT CONTROL
L. REPORTS TO NRC
M. REGISTRATION OF MATERIAL AND EQUIPMENT
N. QUALITY ASSURANCE
O. ACCESS REGISTRATION
P. PROCUREMENT
Q. ALARM ANNUNCIATIONS
R. ACCOUNTING

FIGURE 4.13. Records and Reports Requirements in the Regulations

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would be an important part of the requirements. Although a number of activities can be defined which serve the function, it is difficult to measure their performance. However, the knowledge that a licensee is in compliance with a detailed set of material control and physical protection requirements may serve to deter a potential adversary from considering a malevolent act.

Base 19 lists fourteen elements which may provide deterrence. Figure 4.14 shows the classification of the regulations in the context of this base. As shown, the majority of the elements are not considered or indicated in the regulations. Only information restriction (element I), vehicle markings (element K) and tamper-safing or indicating (elements M and N) are mentioned in the regulations.

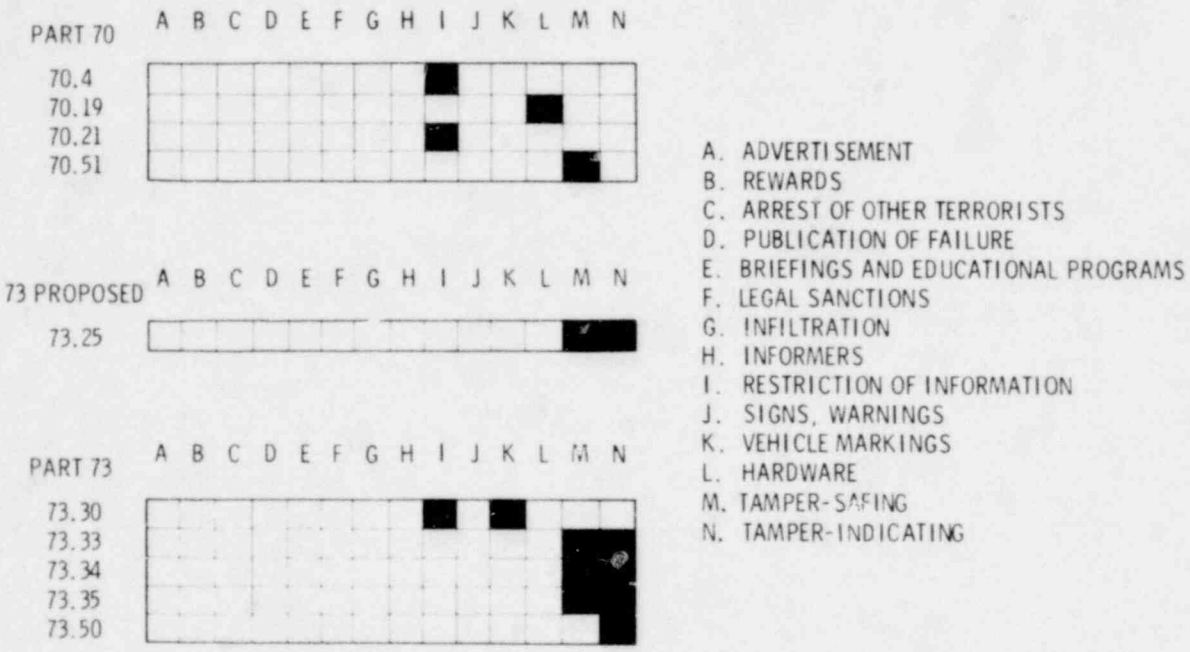


FIGURE 4.14. Classification of the Regulations Dealing with Deterrence

Base 20 - Assurance. Section 4.2 of this chapter gave assurance as one of the primary intents of the regulations. To some, as discussed in Chapter 3, assurance can be considered the purpose or singular goal of the safeguards regulations. Base 20 defines assurance as "measures to satisfy the NRC and the

public that safeguards are in place and can provide protection against attempted acts or theft, diversion, or sabotage that would significantly increase the risk to the public health, injury, or property damage." This definition is characteristic of the "risk" orientation approach to structuring safeguards concerns.

The elements of Base 20 serve to characterize activities that, if related to performance, would serve the function of assurance. The creation of this base was somewhat difficult, since many more activities can be interpreted as providing assurance. Similarly, there were more subjective decisions regarding the content of a given requirement in classifying within this base than with any other. Assurance measures can be in the form of procedures or specifications that satisfy the public or the NRC that safeguards are in place and provide protection.

Figure 4.15 gives the regulations that were identified as dealing with assurance. As shown, a majority of the regulations can be viewed as providing assurance in one form or another according to the elements defined for this base. In Part 70 the most common element referred to is quality assurance. Here, it is the obligation of the licensee to exhibit in his application that he has planned his procedures to provide quality assurance. The term, "quality assurance" is not defined in the regulations.

In Part 70, the principal assurance concerns appear as part of the material control and accounting sections (70.56 through 70.58). Elements used in these sections include tests, performance (of measurements), audits (of material quantities) and inspections. The systems in Part 73 involve the activity of personnel providing physical protection. The elements in the base, as seen in Figure 4.15, can apply to both human and physical systems.

Base 21 - Communications is designed to characterize the requirements in the regulations for communications that are not in the form of formal records or reports. This includes locations, facilities, and procedures that employees of the licensee must follow in the conduct of normal activity or during certain events.

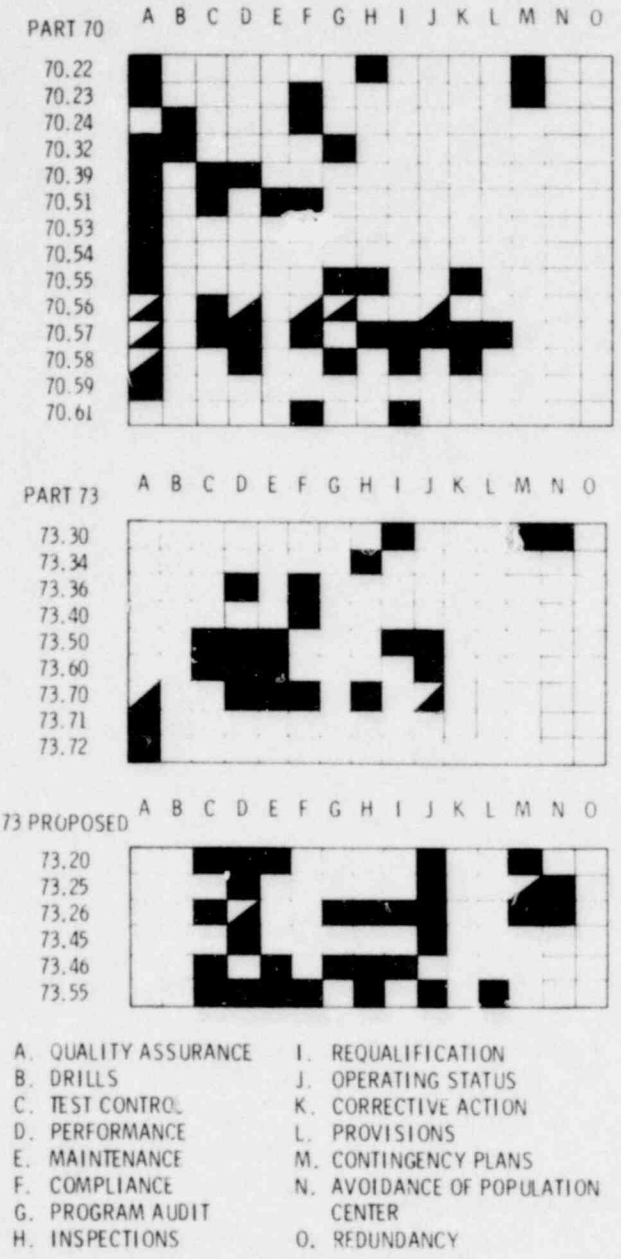


FIGURE 4.15. Assurance

In Part 70, which deals primarily with licensing, few references are made to communication in the forms covered by this base. In Section 70.42(d), Transfer of Special Nuclear Material, oral communication is given as acceptable for emergency situations, provided that written confirmation is used to record the situation. In the case of accidental criticality, the licensee must

report immediately by telephone, telegraph, mailgram, or facsimile, the occurrence to his regional NRC office. This is specified in Section 70.52(a) and is also noted as a means of reporting in Base 18.

In Part 73, Physical Protection Requirements for Plants in Facilities, a number of communication requirements were identified. For transportation, Section 73.25, paragraph (d) requires a communication network as part of the response capability to:

> (i) Enable the escort commander to communicate on routine and nonroutine situations to a movement control center for assessment of the status and position of a shipment;
> (ii) Enable the movement control center to commander to assist in carrying out actions as identified in the safeguards contingency plan;
> (iii) Enable the escort commander to communicate with escort vehicles for implementation of the safeguards contingency plan; and
> (iv) Enable both the escort commander and movement control center to notify law enforcement authorities of need for assistance as specified in the safeguards contingency plan.

Section 73.26 further elaborates on these requirements by specifying, for each transport mode, a set of communication requirements. For shipments by road, cargo and escort vehicles require continuous, redundant communication both intraconvoy and with the movement control center. For shipment by rail the additional specification of coded signals are given. The elements of Base 21 that were identified for this section are: A. Common Language; B. Control Station, D. Transport, H. Non-voice, K. Primary, secondary, N. Timing and O. Report Status.

In the main body of the regulation for transport, Sections 73.31 and 73.33 for shipments by rail and air respectively, communications are also specified. Those are given in 73.31(b) and 73.33(a) and deal mainly with timing of regular communications. Ship-to-shore communications are required for sea shipments in Section 73.34(d).

Communication requirements for fixed sites are not as well defined in setting timing or schedules. Section 73.45 requires: "Communication subsystems and procedures to provide for notification of an attempted unauthorized

or unconfirmed removal so that response can be such as to prevent the removal." Section 73.46 elaborates on both communication and alarm annunication requirements. Paragraph(e) of this section addresses alarm and detection systems including annunication requirements. Paragraph(f) deals with communications subsystems and paragraph(g) of Section 73.46 identifies performance testing and maintenance requirements. The requirements of this section (73.46), serve to support the requirements given in Section 73.50 paragraphs(d)-(f). Section 73.55 lists similar communication requirements for power production facilities.

Base 22 - Security Organization, is similar to the above base dealing with communication in that the majority of requirements are specified in the proposed regulations for Part 73. As defined in Base 22, the security organization is the coordinated activity between the people and the objects in the safeguards system. The necessity of a security organization is only implied within the license application requirements in Sections 70.22 and 70.23.

In Part 73, Section 73.50 requires that the licensee establish a security organization, including guards to protect his facility against industrial sabotage and the SNM in his possession against theft. Paragraph(a) of Section 70.50 goes on to require a supervisor on site at all times, written security procedures, and proper training of guards. These general requirements are further elaborated in Sections 73.45 or 73.46 of the proposed regulations. The specification of these two sections are intended to meet the general performance requirements of Section 73.20. Section 73.45 serves to elaborate on the performance requirements. Section 73.46 further elaborates on the fact that the security organization is charged to conduct the protection activity at the specified level of performance.

The security organization requirements in Section 73.46 may be summarized as:

> The licensee must establish a security organization. He must have at least one full-time member on site at all times with authority to direct physical security activity and he must have a management system to implement and enforce security procedures. These procedures must be documented and approved by NRC in the original and all revised forms. The qualification, training, and evaluation of guards is spelled out in Appendix B of Part 73, "General Criteria for Security Personnel."

Given the security organization requirements in Section 73.46 and Appendix B of Part 73, the elements of Base 22 are all covered at a general level for this section. In Sections 73.46 and 73.55, a new personnel designation is introduced, "armed response individual", whereas only guards are designated in the current sections. The requirements in Section 73.55 for protection of power production facilities parallel those of the other types of facilities.

For physical protection of transit operations, Sections 73.30 through 73.36 do not specify a security organization per se, however, duties and responsibilities of guards and agents are given for the specific transport operations. The establishment of a security organization for transit operations is given in Section 73.25 as part of the performance requirements. The purpose of the security organization is to provide response and the licensee must:

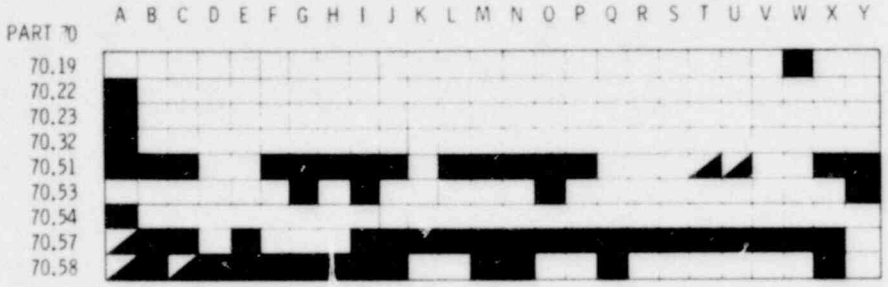
> (i) Provide trained and qualified personnel to carry out assigned duties and responsibilities, and
> (ii) Provide armed escorts to respond to and coordinate transport and escort activities for routine security operations and safeguards contingencies.

As with the requirements for fixed site operations, (e.g., Section 73.46 supports the general performance requirement of Section 73.45), Section 73.26 elaborates on the requirements of 73.25 for transit security. Paragraph(c) of Section 73.26 specifies that the licensee establish a security organization for transportation in a manner parallel to that set forth in Section 73.46 for fixed sites. In this case, a movement control center is required and no mention is made of the organization being separate from the fixed site security organization if a licensee should also conduct shipping operations.

Base 23 - Accounting is perhaps, the most detailed base in terms of the types of activities listed as its elements. Organization of the regulations dealing with material accounting were found not to require the detail used in the base. Only ten sections of the regulations were classified as dealing with one or more of the elements of the accounting activity.

Figure 4.16 gives the classification for Base 23, Accounting. Herein, accounting is interpreted as serving the intent of material control; however,

the terms material control and accounting are usually coupled. As shown in the figure, Part 70 is the primary part of the two surveyed dealing with this base. The accounting function was perhaps the easiest to explicitly identify in any of the sections reviewed.



A. ACCOUNTABILITY
B. ACCURACY
C. ADJUSTMENT
D. AUDIT
E. CORRECTIVE ACTION
F. CUSTODY
G. DISCARDS
H. INVENTORY
   1. BEGINNING INVENTORY
   2. BOOK INVENTORY
   3. ENDING INVENTORY
   4. FISCAL YEAR END INVENTORY
   5. IN-PROCESS INVENTORY
   6. PHYSICAL INVENTORY
   7. WRITE-OFF
I. MEASUREMENTS
J. MATERIAL BALANCE
K. QUALITY CONTROL
L. SAMPLING
M. SHIPMENTS
N. RECEIPTS
O. RECORDS
P. UNACCOUNTABLE
Q. MEASUREMENT SYSTEM
R. REFERENCE STANDARD
S. TRACEABILITY
T. RANDOM ERROR
U. SYSTEMATIC ERROR
V. UNCERTAINTY
W. CALIBRATION
X. LIMIT OF ERROR
Y. MEASUREMENT ERROR

FIGURE 4.16. Accounting

The major sections dealing with accounting are 70.51, Material Balance, Inventory, and Records Requirements; 70.57, Measurement Control Program; and 70.58, Fundamental Nuclear Material Controls. As shown in Figure 4.16, the three sections together cover all the elements used in the accounting base. Other sections shown in the figure were classified as dealing with one or several specific aspects of the accounting function.

Base 33 - Consequence Reduction is the last based defined to classify safeguards system functions. As can be seen from their review, the regulations

deal with consequence reduction by a priori rather than post priori activity. Only Section 70.24, dealing with criticality accidents was classified vs concerned with consequence reduction as considered in this base.

In classifying the regulations with respect to their function eleven bases were defined. Several general and specific observations related to each base can be made:

- *The major functional organization of the regulations is a separation between (1) material control and accounting and (2) physical protection of materials and facilities.*

- *The content of the regulations allowed relatively simple separation for the following bases or functions:*

  Base 13 - Access Control
  Base 19 - Records and Reports
  Base 21 - Communications
  Base 22 - Security Organization
  Base 23 - Accounting

- *The remainder of the bases dealing with functions had no specific sections or paragraphs in the regulations dealing explicity with the function.*

Specific observations about each base are:

- *The function of access control is confined exclusively to Part 73 dealing with physical protection. This function is oriented primarily to fixed sites yet may be interpreted as a transit concern as well. The contents of Section 73.50 give an overview of the function's requirements.*

- *Surveillance is not separated by the regulations as a specific function. Procedures are up to the licensee to specify as part of the licensee application.*

- *Investigation is treated in the regulations for accounting or shipping losses and assessment of alarms. The function is not spelled out as a separate stage prior to response for physical protection.*

- *The regulations do not define a sequence of activities from detection to response but do require such consideration in a physical security plan.*

- *The a priori function of planning and design must be exhibited in the licensee's application. The majority of the regulations can be implicitly interpreted as dealing with one or more aspects of the elements in this base.*

- *Classification of the regulation in terms of records and reports showed that documentation was required for the majority of safeguards functions. Of particular importance were changes in established functions, accounting records, or the documentation of abnormal situations.*

- *Deterrence is a function of safeguards as well as a safeguards intent. Classification for this base indicated the regulations did not explicitly address this function.*

- *A performance-oriented regulation can be interpreted as providing assurance. A number of the regulations were interpreted as providing assurance, however this function was never the specified objective of a given requirement.*

- *Communication, as a function, is different from records and reports by the fact that it is an active part of physical protection. The proposed regulations in Part 73 detail communication as a function necessary at both fixed sites and during transit of material.*

- *Security Organization is required to carry out safeguards functions. This need is characterized in Section 73.50 and in the proposed regulations for both fixed sites and transit activity. A parallel requirement structure was identified for the two above categories.*

- *Accounting, as a function is easily singled out in the content of the regulations. It is primarly contained in Part 70, Sections 70.51, 70.57 and 70.58.*

- *Consequence Reduction is defined as activities which occur after an occurrance such as accidents or resulting from adversary acts. The regulations primarily deal with a priori methods which may be interpreted as reducing possible consequences.*

4.7 EQUIPMENT AND SECURITY AREAS

The regulations dealing with procedures and specifications can sometimes specify the types of devices (e.g., two-way communications systems) or designate areas or locations having differing safeguards requirements (e.g., protected areas). Five bases were defined to allow classification of the regulations for these concerns:

Base 24 - Intrusion and Detection Devices
Base 25 - Alarm and Communication Systems
Base 26 - Security Areas
Base 27 - Armament, Protective Equipment
Base 29 - Location in the Safeguards System

An additional base, Base 28 - Other Safeguards Equipment, was defined as a "catch-all" for any additional equipment not covered in the above bases. Included in Base 28 are such items as locks, keys, uniforms, vehicles, signs, etc., which cannot be classified as part of the other bases dealing with equipment.

Of the six bases in this grouping, Base 27 - Security Areas was found to have the most utility in classification. The regulations do not explicitly specify equipment beyond the general requirements. However, the designation of security areas, corresponding to a desired level of protection, is an important concept in the regulations.

The elements comprising the above bases fall within natural categories already used in previous bases. For example, intrusion and detection devices are supportive of the access control and surveillance functions. The functions of communication and investigation are supported by the alarm and communication system. The general protection of a facility or transit operation requires a designation of specific areas within the system being protected. Similarly, to adequately define a level of response to an adversarial action, the location of the adversary with respect to the material is important. Finally, the equipment used by the security organization such as weapons or protective devices comprises another base. Many of the elements in Base 28 - Other Safeguards Equipment may be considered as part of one of the other bases in its grouping, e.g., locks may be considered as providing deterrence.

Bases 24 and 25, Intrusion and Detection Devices and Alarm and Communication Systems can be considered jointly in terms of reference to such equipment in the regulations. In Part 70, Sections 70.22 and 70.23 give the general requirements for a physical security plan. If necessary, the licensee must provide the details regarding the equipment and procedures for use as part of his plan. In general, Part 70 does not specify detailed requirements for such devices.

Part 73, dealing with Physical Protection, has a number of sections referring to "devices affecting the effectiveness, reliability, and availability of the physical protection system." Section 73.20, General Performance

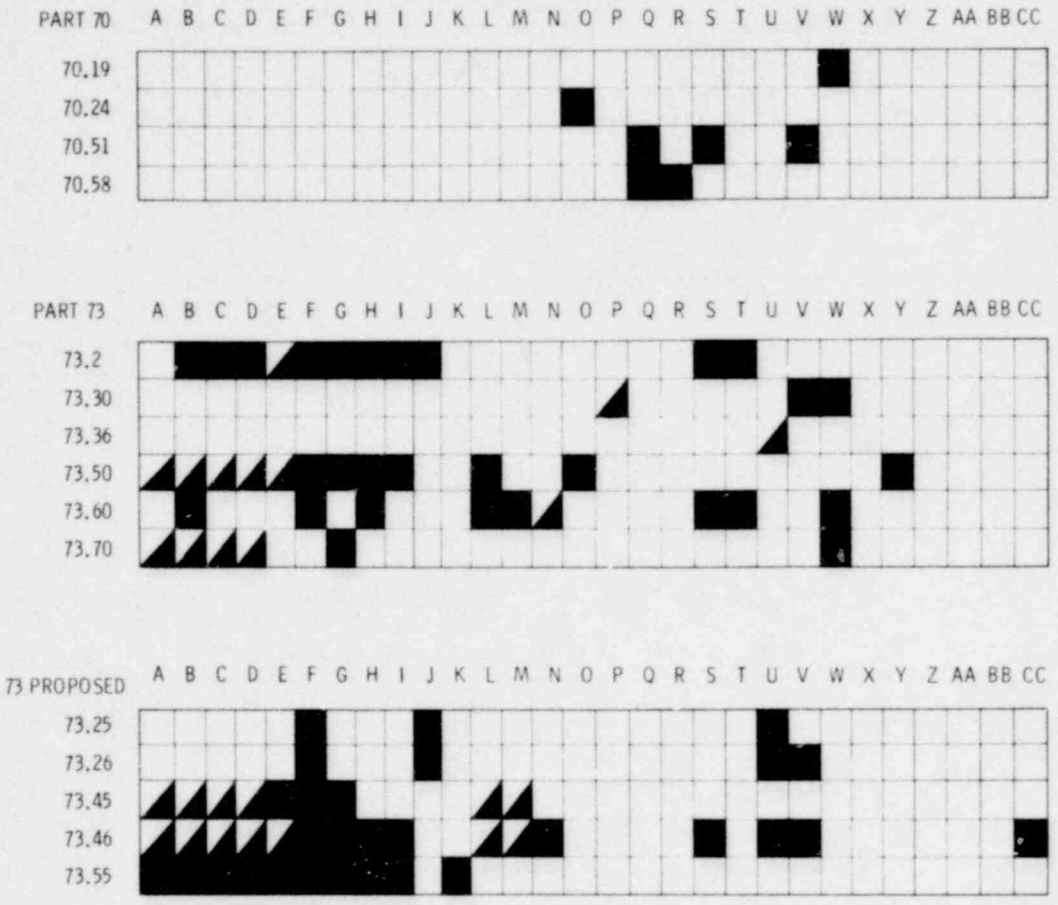
Requirements, refers to a testing and maintenance program in paragraph(b), but does not specify devices of a given type. For transit protection, Sections 73.25 or 73.26 refer to access detection or control subsystems in paragraphs 73.25(g) and 73.26(f) and alarms or communication subsystems in 73.25(d) and 73.26(g), (i) and (j). For physical protection at fixed sites, Section 73.45 gives general requirements regarding devices, again referring to subsystems for detection, surveillance, and communication. Section 73.50 has several paragraphs also dealing with these requirements: Paragraph 73.50(c) refers to access, 73.50(d) detection, 73.50(e) communication, and 73.50(f) testing and maintenance of such systems. Section 73.46 further elaborates on the various systems of devices in a parallel manner. Table 4.4 summarizes the content of the various regulation dealing with the elements of Bases 24 and 25. As shown, the majority of device specifications are given in the "proposed regulations" of Part 73.

Base 26 - Security Areas. The safeguards regulations designate various areas by degree of access to nuclear materials. Depending on the degree of access, the various designated areas require different levels of protection. Areas are regions bounded by barriers and accessed by portals. Other areas within the safeguards system are various designated zones. At the final point of material access, containment vessels and packages may be considered as security areas as well.

Figure 4.17 gives the regulations classified as dealing with Base 26. Part 73 provides the majority of regulations classified for this base. Note that a number of implied classifications were made in the figure. For example, Section 73.50 Paragraph(b) deals with physical barriers. However, no barriers of a specific type given as elements in the base are singled out in the paragraph. Protected areas are most commonly referenced in the regulation, particularly in the proposed upgrades to Part 73. In Figure 4.17, a number of specific observations can be made. For example, emergency exits (element 0) are required as part of criticality in Section 70.24 or protected via 70.50. Vaults and vault-type rooms are used together in Section 73.60 but only vaults are addressed in 70.51 for material control and 73.46 for protection of fixed sites.

TABLE 4.4. Device Requirements for Physical Protection

General Requirements	
(1) Testing and Maintenance program to assure control over all activities affecting the effectiveness, reliability and availability of the physical protection system including a demonstration that any defects of such activities and devices will be promptly detected and corrected...	73.20(b)(3)
Transit Protection	
(1) Access detection procedures or subsystems.	73.25(b)(iii) 73.26(f)
(2) Tamper indicating devices, seals.	73.25(c)(2)(ii) 73.26(f),(g)(j) 73.30(c) 73.31(c)(i) 73.34(b) 73.35(b) 73.70(f)
(3) Surveillance Subsystems, monitoring	73.25(c)(2)(iii) 73.26(c)(2)
(4) Communication Center	73.25(d)(3)(ii) 73.26(i)(4)
(5) Testing and Maintenance	73.26(k)
(6) Communication devices, networks road air rail ship	73.25(d)(3) 73.26(g)(6), 73.31(c)(1) 73.26(h)(7) 73.26(i)(4), 73.73(a) 73.26(j)(6),
Fixed Site Protection	
(1) Detection System, aids and devices	73.45(b)(ii) 73.45(d)(iv) 73.45(e)(ii) 73.45(f)(ii) 73.46(d) 73.50(d) 73.55(e)
(2) Access Control Systems	73.46(d) 73.50(c) 73.55(d)
(3) Detection and Alarm Subsystems	73.46(e) 73.50(e) 73.55(e)
(4) Communication Subsystems	73.45(e)(iii) 73.46(f) 73.50(e) 73.55(f)
(5) Testing and Maintenance	73.46(g) 73.50(f) 73.55(g)



A. BARRIER, VEHICLE OFFSITE, ACCESS
B. BARRIER, FENCES
C. BARRIER, WALLS
D. BARRIER, CEILINGS AND FLOORS
E. BARRIER, OTHER
F. PROTECTED AREA
G. VITAL AREA
H. MATERIAL ACCESS AREA
I. ISOLATION ZONE
J. TEMPORARY EXCLUSION AREA
K. EXCLUSION AREA
L. PORTALS, PEOPLE, INGRESS
M. PORTALS, PEOPLE, EGRESS
N. PORTALS, MATERIAL
O. EMERGENCY EXITS
P. PACKAGE, PACKAGING
Q. MATERIAL BALANCE AREA
R. ITEM CONTROL AREA
S. VAULT
T. VAULT-TYPE ROOM
U. MOVEMENT CONTROL CENTER
V. CONTAINMENT
W. CONTAINMENT VESSEL
X. ACCESS DENIAL APPARATUS
Y. LIGHTING
Z. OTHER AREAS
AA. BREACHES
BB. CAMOUFLAGE
CC. WINDOWS, BULLET-RESISTING

FIGURE 4.17. Regulations Specifying Security Areas

Base 27 - Armament, Protective Equipment. As with Bases 24 and 25, references to specific equipment in terms beyond general performance requirements are not made in the regulations. Similarly, for this base, (Base 27) only the regulations in Part 73 mention armament equipment. The regulations of Part 71, in effect, deal with protection from radiation by packaging, but do not express this fact.

The new regulations in Part 73 are the major source of requirements for armament. The new Appendix B of Part 73, General Criteria for Security Personnel, provides training and general firearms qualifications for the personnel. Note that in these upgrades, a new designation of "armed response individual" is made to supplement the definition of guards or watchmen. Section 73.26 paragraph(c) requires armed escort personnel to have handguns, shotguns, and semi-automatic rifles consistent with local conditions. Section 73.46 parallels the above for fixed sites. Paragraphs 73.46(b) and (g) give the same requirement for guards and armed response individuals at fixed sites. Use of such weapons is given as being of a sufficient degree to counter force directed at the security personnel. Section 73.55 has the same requirement as 73.46.

In the remainder of the regulations, Section 73.30 paragraph(e) mentions armed escorts; Section 73.31, an escort of two armed guards for road shipment; 73.32 unarmed escorts for shipment by sea (which is contradicted by 73.26(j)(2) which requires armed escorts). In 73.32 for air export shipments, another contradiction is made by 73.26(h)(5); the former requires an unarmed escort and the latter designates three armed individuals. For transfers, discussed in Sections 73.35 and 73.26(e), armed escorts are required in the latter paragraph. Section 73.50, which provides general requirements for physical protection at fixed sites does not mention any armament requirements.

The regulations do not list any safety equipment for personnel from adversary attack, fire protection, or otherwise. No benign weapons are specified as an option in the regulations, e.g., element 27-E, Aerosol Irritants), and no weapon calibers or military type equipment (e.g., used as SWAT teams) are designated. However, Appendix B of Part 73 does indicate training on certain of these devices.

Base 28 - Other Safeguards Equipment has several appearances throughout the regulations, due primarily to its general nature. In Part 70, measurement systems for criticality are required in Section 70.24, measurement tests for the manufacture or import of calibration or reference sources in Section 70.39, and measurement systems for material control and accounting in Sections 70.51, 70.57 and 70.58.

In Part 73, locks are defined in Section 73.2 Paragraph (m). Table 4.5 lists the remaining elements and their appearance in the regulations at the section level.

TABLE 4.5. Other Safeguards Equipment

Element (Base 28)	Section
(A) Locks	73.26, 73.30 73.33, 73.34 73.50, 73.55 73.60, 73.70
(B) Keys, card keys, combinations	73.46, 73.50, 73.55, 73.70
(C) Uniforms	--
(D) Vehicles, fixed site	73.46, 73.50, 73.60
(E) Vehicles, transport	73.25, 73.26, 73.30, 73.31, 73.36
(F) Badges	73.26, 73.46, 73.50, 73.55

The final base in this section, Base 29 - Location in the Safeguards System, can be interpreted as being oriented in two ways. First, the security areas used by Base 26 are defined in terms used currently by the regulations. As can be seen by Figure 4.17, their use can be somewhat confusing. For physical protection of either facilities or transit operations, the security areas may be designated with respect to the proximity or level of control as one becomes closer to material access. The majority of elements in this

base are, however, oriented to fixed sites. The second viewpoint is also one of level of control with respect to procedures for dealing with adversaries. The adversary location with respect to the material may indicate the severity of their intent or indicate a necessary response level.

In the regulations it is easy to distinguish whether a requirement deals with fixed site or transit (offsite) operations. However, in classifying the regulations for this base, no organizational structure along either of the above lines is readily apparent. The physical protection requirements are not presented hierarchically with respect to location of a given detected activity. Similarly, no graduated set of responses is provided. Obviously, material control and accounting requirements are within the proximity of the material or fence specifications are at the boundary of a protected area, but the regulations are not so structured.

To summarize this section, covering concerns about equipment and security areas, the following observations can be made:

- *The regulations do not provide detailed requirements regarding detection, alarm or communications systems beyond general performance requirements given in the proposed physical protection upgrades.*

- *Security areas are used in a number of the regulations to designate physical areas requiring control. Although the designations are not conflicting, a common, simpler set of terms would allay some confusion in interpreting the requirements.*

- *Armament is specified by the upgrade rules and Appendix B of Part 73 and increases the number of, or now requires, armed guards (escorts) for most activity.*

- *The regulations do not provide a hierarchy of graduated protection or response dependent on location of an event. The regulations do vary dependent on location for access control and other functions.*

4.8 ADVERSARIES

The classification of the regulations with respect to adversary activity are depicted in Figure 4.18.

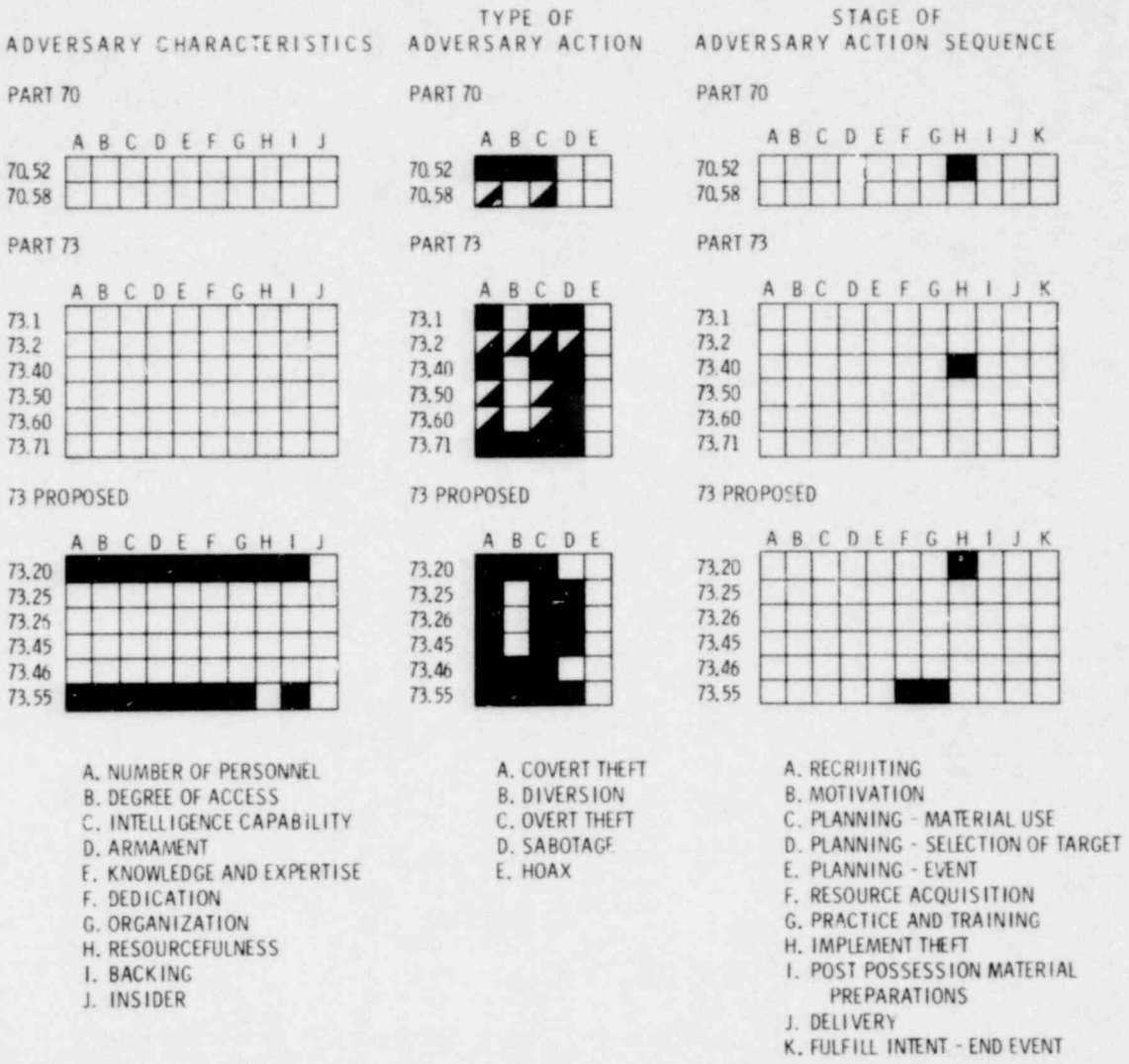
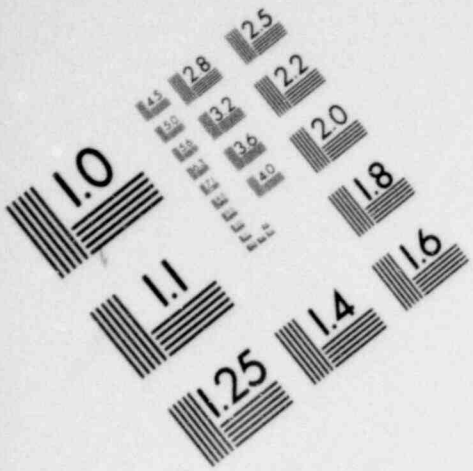


FIGURE 4.18. Classification for Adversary Activity



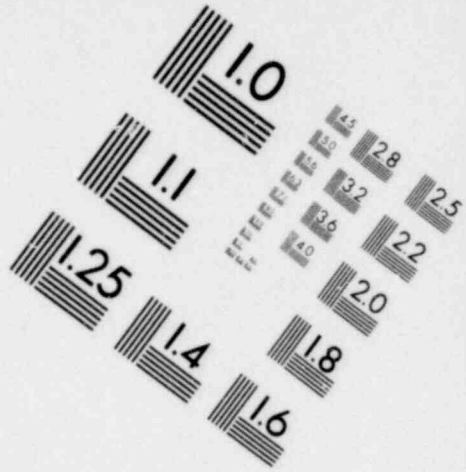
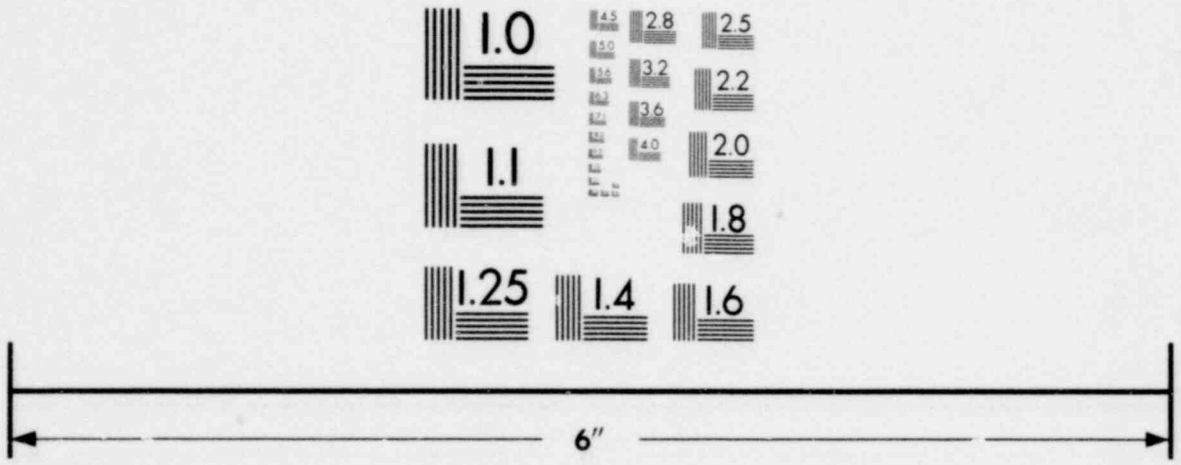
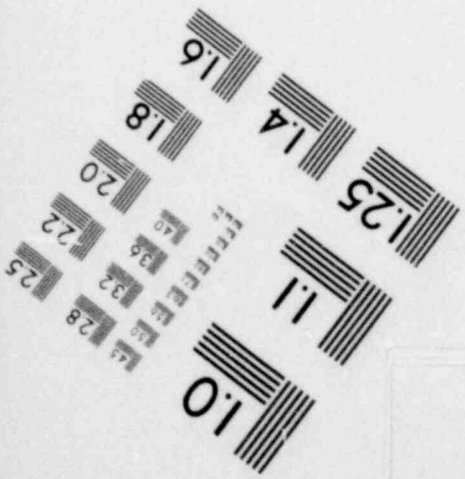
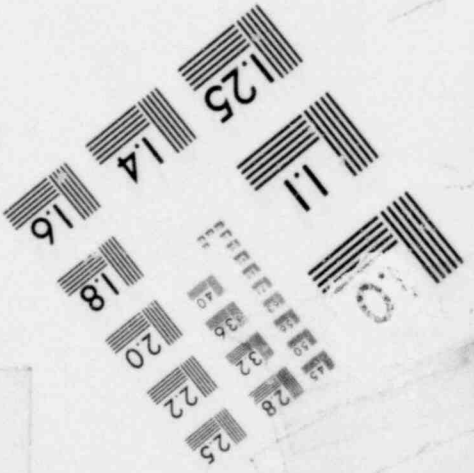
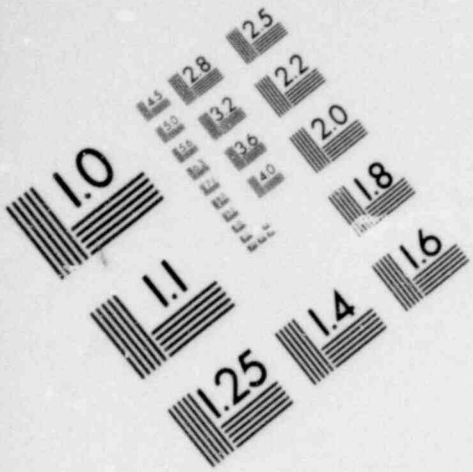


IMAGE EVALUATION
TEST TARGET (MT-3)









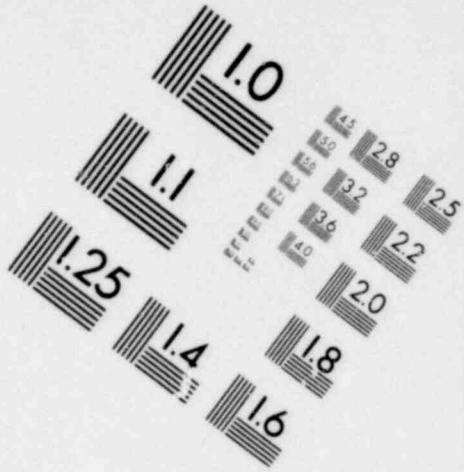
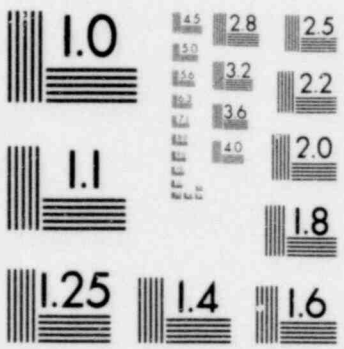
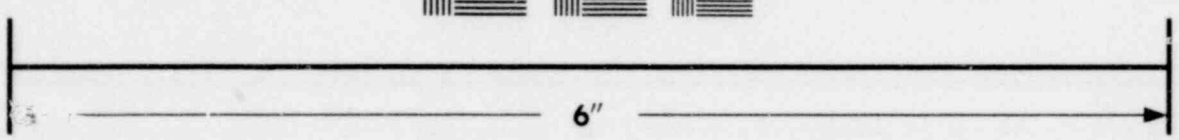
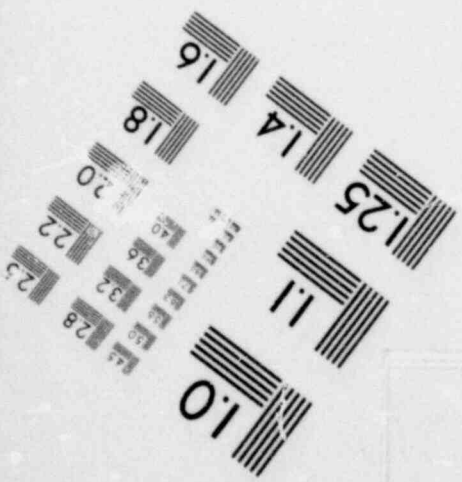
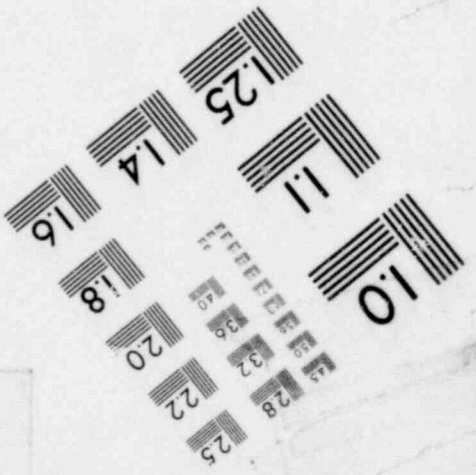


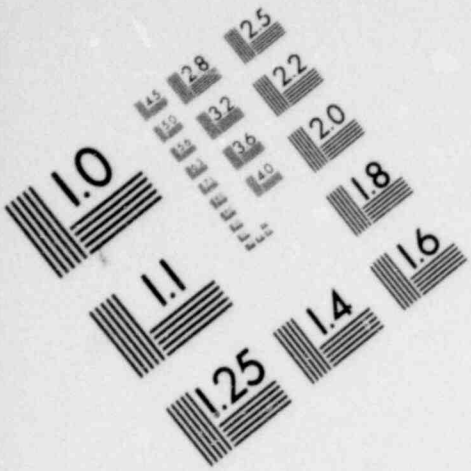
IMAGE EVALUATION TEST TARGET (MT-3)











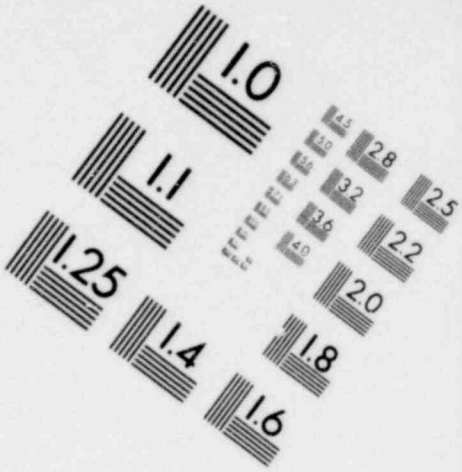
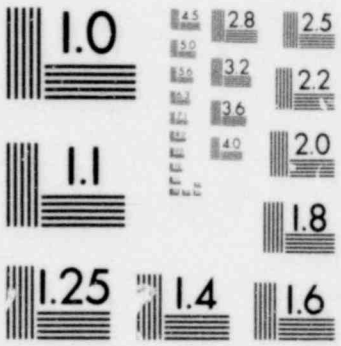
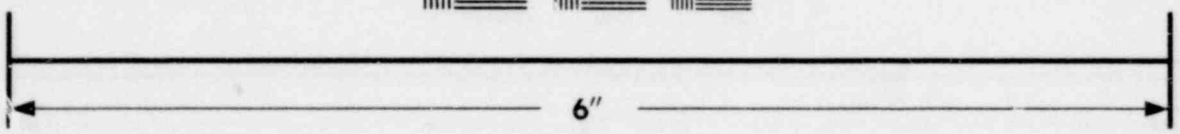
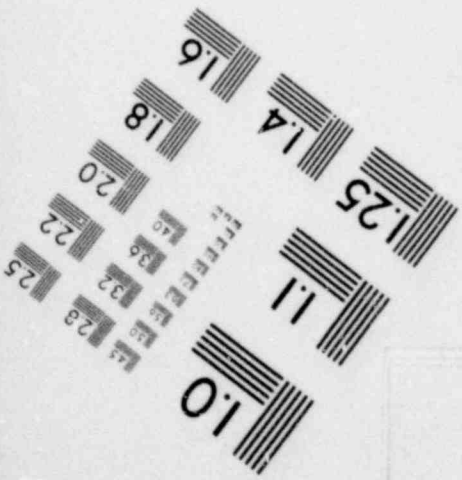
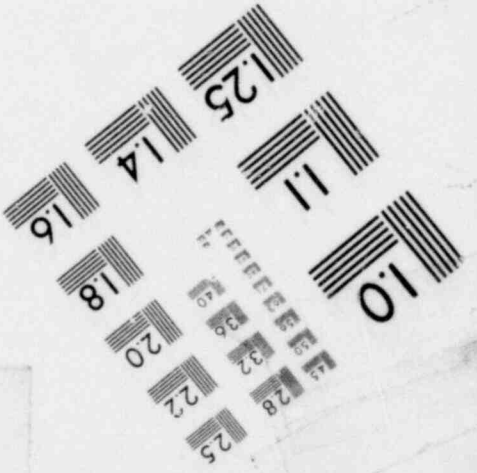


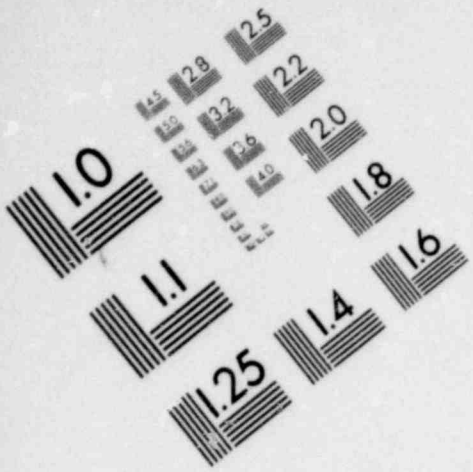
IMAGE EVALUATION TEST TARGET (MT-3)











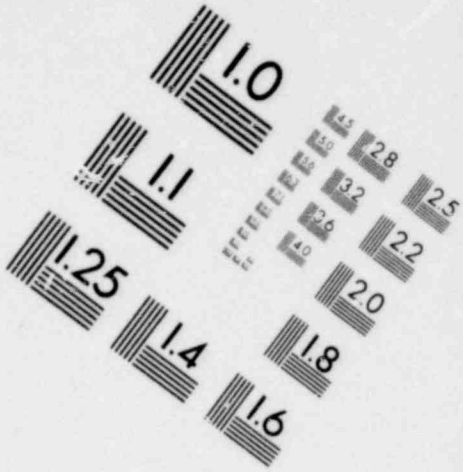
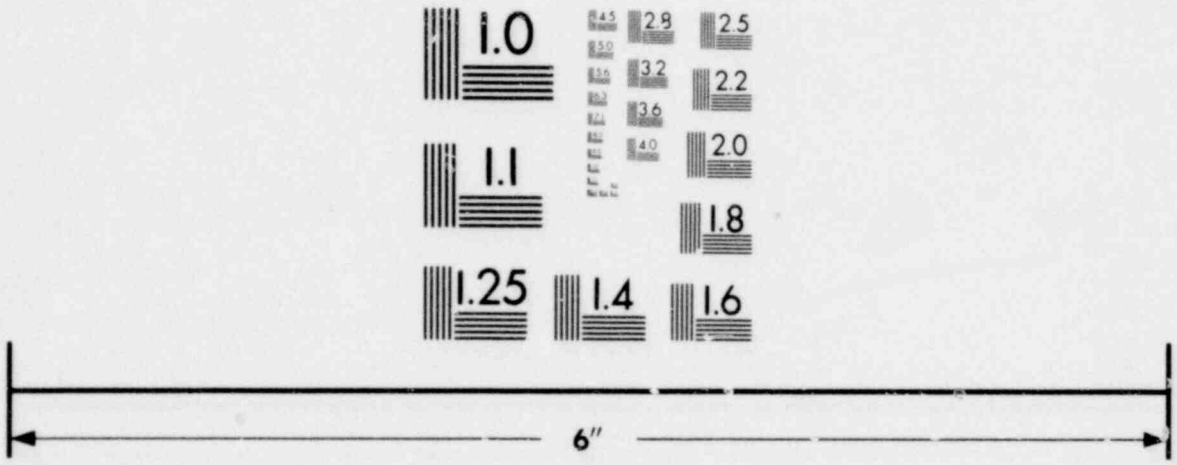
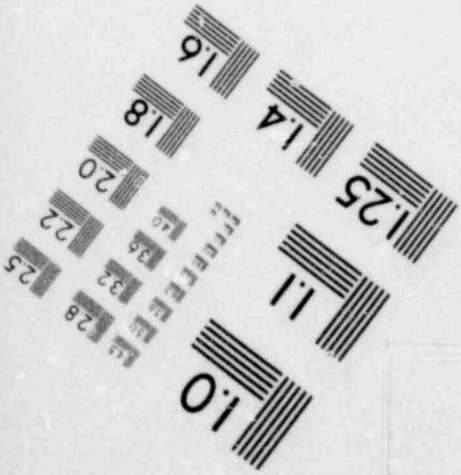
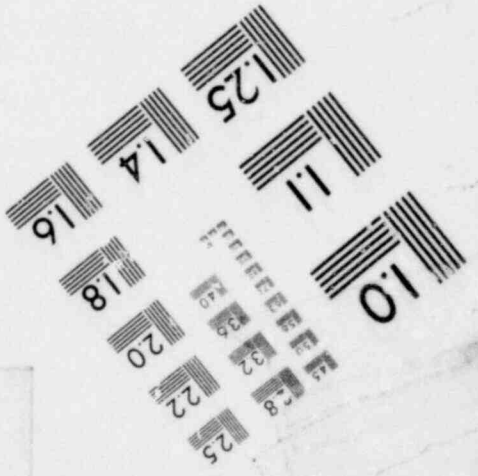


IMAGE EVALUATION TEST TARGET (MT-3)







Three bases were defined to classify the contents of the regulations from an expected adversary activity or characteristics. These bases are:

Base 30 - Adversary Characteristics
Base 31 - Type of Adversary Action
Base 32 - Stage of Adversary Action Sequence

For Base 30 only the proposed physical protection rules cover a set of hypothetical adversary characteristics. Section 73.20 gives general requirements for physical protection performance. Section 73.55 is similar for protection of power reactors.

The type of adversary action most commonly referred to the regulations is "radioactive sabotage." Base 31 defines 5 categories of thefts including hoaxes. Note that the hoax threat is not addressed in the regulations. It is also difficult to distinguish a diversion threat from a sabotage threat.

For purposes of deterrence, the stage of adversary activity may be an important consideration. Base 32 gives eleven stages of possible adversary activity. The regulations are not specifically oriented to any activity except protection from the actual act. This is reflected by the third category shown in Figure 4.18.

The orientation of the regulations with respect to adversaries can be characterized:

- *The regulations deal only with direct adversary actions including theft, sabotage, or diversion. Adversary attributes are considered only as general levels of performance - Sections 73.20 and 73.55.*

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5.0 INTERACTIONS

Only where the safeguards regulations interact, e.g., deal with the same elements, does there exist the possibility of contradiction. In the previous chapter, the regulations' content was presented in a systematic manner that helped identify multiple areas of coverage. This chapter focuses on the key areas of overlapping content within Parts 70 and 73 of the regulations.

The safeguards regulations interact in several different ways, primarily depending on the elements that several regulations may address. Section 5.1 discusses how the regulations may interact and surveys the major interactions observed in classifying the content of the regulations. Subsequent sections focus on three areas where the regulations interact. Those areas are:

- license applications and conditions
- material control and accounting, and
- physical protection.

These are considered in Sections 5.2 through 5.4 respectively.

The methodology developed for this study can also be used to identify areas not covered by current regulations. This is shown in Section 5.5 which also provides general observations regarding interactions and how they relate to the structure of the regulations. The findings are summarized in terms of consistency and possible contradictions.

5.1 CHARACTERIZING THE INTERACTIONS

Two or more regulations can interact at several different levels of generality. Recall Figure 2.2 which depicts a hierarchy for the various factors of concern in the regulations. This hierarchy was used to exhibit that a regulation may specify a number of activities and functions to meet a given objective.

By applying the methodology to classify the content of the regulations, it is also possible to identify multiple areas of coverage. The presentation of Chapter 4 grouped the regulations by content into subsets dealing with one

or several elements in each base considered. If a given element is found to be covered by two or more regulations, then that indicates a possible interaction between the regulations.

To elicit possible interactions between regulations, it is necessary to compare the classifications for pairs of regulations to identify common elements; i.e. those "covered" by both. This, of course, does not necessarily mean that the interaction is a contradiction. In general two or more regulations can interact in one of the following ways:

- *Do not affect the same safeguard elements (no interaction)*
- *Cover the same elements in a neutral way (complying with all the regulations is the same as complying with each separately.*
- *Affect the same elements in a positive way (the regulations support or clarify one another making compliance less difficult)*
- *Affect the same elements in a negative way (complying with all the regulations is more difficult than complying with each separately; in the extreme case, the regulations contradict one another).*

Only in the last category above could several regulations interact in a negative manner indicating a contradiction. The general observation from studying interactions among the regulations is that although they do interact extensively, they interact in either a neutral or positive manner. This should be expected since the regulations are intended to function as a "whole" rather than as a set of separate parts.

The lack of a systematic structure for the regulations obscures a number of the supportive relationships among the regulations. The current numbering system used to index each of the Sections in each Part of 10 CFR is intended to help establish precedence relations for the regulations. For example, in Part 73, Physical Protection of Plants and Materials, the sections numbered 73.30 through 73.36 deal with transit protection; Section 73.30 gives general requirements for all modes of transit and 73.31 through 73.35 deal with specific modes or transfer. The performance oriented upgrades for transit protection are given in Sections 73.25 and 73.26; their numbering indicates that they supplant the various requirements in the current Chapter 10, CFR.

The general performance requirements for physical protection, given in Section 73.20, in turn take precedence over either the set of transit requirements or for fixed sites. Figure 5.1 depicts this relationship.

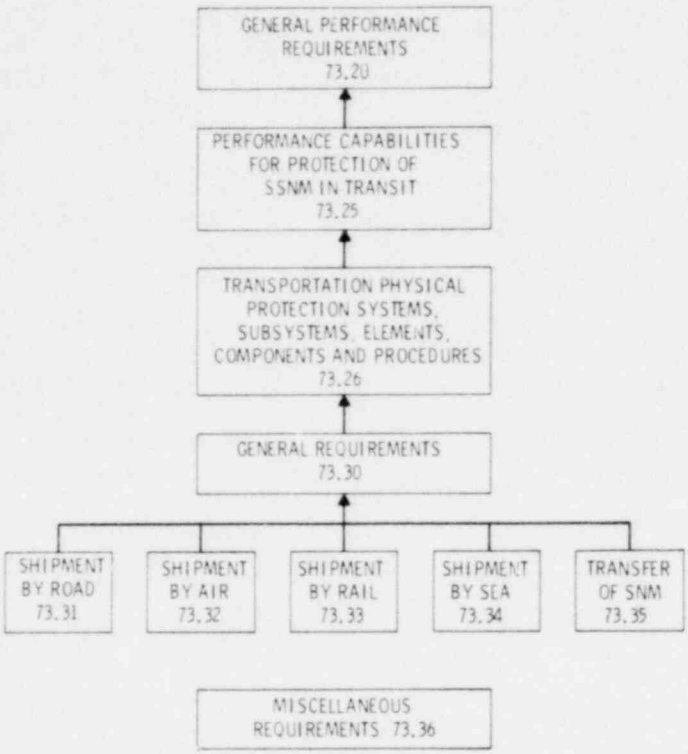

FIGURE 5.1. Precedence Among Transit Physical Protection Requirements

A similar set of precedence relationships showing the interactions of the physical protection regulations in Part 73 can be determined. These are discussed in Section 5.4 of this chapter.

In Chapter 4 the content of the regulations was assessed by reviewing each with respect to the elements within each base. The results of the classification were presented by grouping all of the regulations dealing with a given base. These groupings provide a preliminary set of possible interactions. In effect, all the regulations in a given grouping interact. The objective here is to clarify the complexity of the interactions by structuring and to identify potential negative interactions.

To elicit the key interactions requiring further study, the set of regulations was first reviewed base-by-base. The results of this review are summarized as follows:

Regulatory Requirements. Most of the regulations can be classified as either procedural or performance requirements. A possible basis for conflict occurs when a pair of regulations, one procedural and one performance, addresses the same function or object. The use of the first base, Regulatory Requirements, for classification proved it is difficult to determine a consistent separation between performance and procedural requirements.

A specific example can be found in the proposed regulations of Part 73. Section 73.25, defining performance capability for protecting transit operations, is a performance requirement; Section 73.26, defining transit protection systems is procedural. The latter section in effect specifies the minimum system necessary (in terms of guards, planning, shipping, communication, etc.) to achieve the desired performance. The interaction is positive in that complying with Section 73.26 supports compliance with Section 73.25.

The regulations that were classified as being either performance or procedural (or both) interacted in a neutral or positive manner.

Regulatory Activity includes those activities conducted by the NRC to meet the requirements of their charter. The majority of the regulations were classified as dealing with licensing. The remainder of the activities found in the classification for this base interact neutrally.

The interactions in the licensing process are detailed in Section 5.2 of this chapter.

Designated Party. One possible way a set of regulations can interact is by affecting the same set of people. The regulations were shown to identify licensees as their primary objects. The regulations identifying other designated parties were perused for possible interactions. The analysis showed that other persons referred to, who were not employees of licensees, were primarily listed as exemptions, e.g., carriers.

The major potential interaction here is in the dichotomy between legal responsibility (compliance by the licensee) and the "command" target as employees of the licensee who must conduct specific activities. It was found that the regulations are explicit about liability; the responsibility of assuring that licensee employees perform their duty is in the hands of the licensees.

The regulations generally designate the licensee as having the responsibility for compliance.

Safeguards Intents. This base was used to help qualify the nature of the regulatory requirements, specifying the aim or purpose of the regulations. Review of the classifications for this base indicated:

Two or more regulations could be identified as having the same intent or purpose, however, possible negative interactions would not occur in conflicting intent but between the activities, functions, or objects that are the direction of the intent.

Operations and Facilities. Four bases were used in Chapter 4 for classifying the various operations and facilities. This general category identified possible areas of interaction that are discussed in more detail in Section 5.3. For facilities, the regulations give material types and quantities as the organizing structure. The regulations were not shown to be organized by detailed process operations at facilities--hence there is no case for interactions. For temporal aspects, the regulations can be interpreted as licensing requirements prior to operations; compliance is the concern after operations commence. Possible interactions based on this separation were not considered to be important.

Section 5.3 addresses the interaction between materials and facilities.

Material Types and Measures. In the regulations, material specifications are primarily by weight, further qualified by enrichment. Table 4.4 gives the requirements organized by the above category. Those results were reviewed for possible interactions and conflicts.

With respect to material quantities specified by weight, the regulations give a wide variety of levels for differing requirements. The main cause for confusion stems from the different amounts that are specified, often within the same section of the regulations. For example, Section 70.51 gives several levels of control for material control and accounting purposes. The structuring and classification process indicated no major contradictions in the regulations. However, part of the possible confusion could be allayed by considering the regulatory requirements by a "top down" approach as presented in Table 4.3. For example, a potential licensee may know in advance the material amounts and types that he expects to deal with. If, as an example, he expects to deal with no more than one effective kilogram at any time, then he would refer to the requirements set on this amount or less.

Material quantities and measures are confusing in the interpretation of the regulations, primarily due to their pervasive use (particularly in Parts 70 and 71). Upon a detailed examination for interactions, no major conflicts were found. However a "roadmap" such as given in Table 4.3 may help allay possible confusion or apparent conflicts resulting from a cursory reading of the regulations.

Performance Criteria. As with Base 4, Safeguards Intents, Base 12 presented a list of possible performance criteria to help qualify the content of the regulatory requirements. The classification of the regulations in terms of possible performance criteria indicated that the exhibit of performance, beyond general specifications, falls on the shoulders of the licensee. The regulations are not oriented toward measuring performance.

Interaction in terms of performance criteria spelled out by the regulations was not considered to be a basis for possible conflict. The licensee could create conflicts in exhibiting performance; however, the regulations do not lend themselves to causing conflicts by their performance requirements.

Safeguards System Functions. The twelve bases used to classify the various functions of safeguards systems span both physical protection and material control. In the conclusions regarding content given at the end of Section 4.5 of this report, only five bases were observed to describe separable functions in the regulations. The various regulations associated with each base can be considered to interact in that they are directed at least in part to a specific function.

Of the various functions considered, interactions were found to be either neutral or positive. Precedence relations were observed among several regulations dealing with a given safeguards function. With respect to function, the primary interactions are within the regulations in Part 73 dealing with physical protection.

For material control and accounting, the regulations that interact within this base were shown in Figure 4.16. The regulations of Part 70, Sections 70.51 through 70.58 deal with material control and accounting. Some overlap exists therein, particularly between 70.51 and Sections 70.57 and 70.58. This reflects the fact that the latter two sections represent a set of upgrades that were added to the requirements. Although there is a degree of overlap, these latter sections support and clarify the general requirements of Section 70.51 and can be considered a positive interaction.

Key interactions among the various safeguards functions occur primarily for those regulations dealing with physical protection. Section 5.4 of this chapter considers these in more detail.

Equipment and Locations. The objects to which the safeguards regulations are directed present a possible set of interactions in the "security areas", as categorized by Base 26. As discussed in Section 4.6 of Chapter 4, the regulations addressing devices or equipment do not give detailed specification.

The designation of security areas within the regulations is, at first reading, confusing and potentially ambiguous. For example, the designation "vault-type room" as opposed to a true "vault" is an ambiguous use of terminology. In an ideal situation, area designations could be characterized with respect to the associated level of protection desired in proportion to its proximity (allowing access) to nuclear material. The actual designations in the regulations do not make such an explicit distinction. Upon carefully reviewing the regulations specifying security areas no negative interactions were found.

Designation of areas or locations in the safeguards system presents confusion regarding possible interactions. This confusion stems from the lack of associating procedural requirements with the area designations. A review did not indicate any major conflicts which would result in contradictions.

Adversaries. Only the upgrade requirements proposed for Part 73 deal with adversaries, and only from a performance viewpoint. The licensee may have difficulty in exhibiting compliance for the various requirements, (e.g., Sections 73.25 and 73.45). No specific security organization may be more suited for one type of threat than another. The physical protection specifications are oriented to dealing with overt acts rather than covert acts of diversion or sabotage.

Conflicts in performance requirements regarding physical protection could occur in the security organization design or procedures necessary to comply with a variety of adversary acts. This possibility of conflict or contradiction was not addressed, nor is there a basis of experience to validate possible compliance difficulties.

Summary

This section has surveyed the review that was performed on the regulations to elicit their interactions. The classification of the content of the regulations provided preliminary groupings of regulations for these considerations. The content of the regulations that were classified as dealing with a given base was reviewed for interactions. Specifically, where two or more regulations were identified as dealing with the same element, they were reviewed in detail for conflicts.

In general, the regulations are intended to act as a whole, not as separate, independent requirements. Hence there are virtually no regulations that do not interact with another at least at some level of generality. A closer look at the possible interactions shows that:

- *Many of the regulations in fact are highly interrelated, primarily in a neutral or positive manner.*
- *When interactions between sets of regulations are positive, then a precedence relation indicating support can be developed.*
- *Although confusing, and not systematically structured, the regulations do not interact in a negative manner; they do not contradict one another.*

The fact that the regulations do not basically conflict is reasonable when one considers that the process of developing requirements is not simple. It reflects the detailed analysis of needed requirements, a knowledge of

current requirements, resolved difficulties in their proper interpretation, experience in compliance, and a review process which includes all the parties involved in creating c meeting their requirements.

Although the above conclusions indicate that the interactions among the regulations are not necessarily negative, several key areas of interaction deserve further consideration. These areas were identified in the above discussion and are discussed in more detail in the next several sections.

5.2 THE LICENSING PROCESS

The first set of interactions in the regulations considered in detail spans the contents of Parts 70 and 73. A major purpose of these parts is to promulgate the conditions for licensing of persons or organizations having nuclear material. Although licensing is a concern of all three parts, the purpose of Part 70--Special Nuclear Material, is given in Section 70.1 paragraph (a) as:

> The regulations in this part establish procedures and criteria for the *issuance of licenses* to receive title to, own, acquire, deliver, receive, possess, use, and transfer, special nuclear material; and establish and provide for the terms and conditions upon which the (Nuclear Regulatory) Commission will issue such licenses.

Part 73, Section 73.1 paragraph (b) prescribes requirements for:

> (i) the physical protection of production and utilization facilities *licensed* pursuant to Part 50 of this chapter (10 CFR) and (ii) the physical protection of plants in which activities *licensed* pursuant to Part 70 are conducted,...

The section also includes physical protection in transportation

> by any person who is *licensed* pursuant to the regulations in Part 70 of this chapter who imports, exports, transports, delivers to a carrier for transport a single shipment or takes delivery of a single shipment free on board at the point where it is delivered to a carrier...

These general requirements exhibit that each of the parts is concerned with licensing. To focus on the various requirements dealing with licensing it is possible to identify two pairs of categories in which the interacting regulations can be grouped. The first separates licensing into:

- content of license applications
- conditions of specific licenses.

To receive a license, an applicant must submit an application that specifies certain detailed information regarding his proposed activity. Dependent on the amounts and types of nuclear material, the activity, and other factors, a specific license or general license will be required. The regulations deal primarily with specific licenses. General licenses are treated by exemption for certain activities or small amounts of nuclear material.

The second pair of categories separates licensing as pursuant to:

- fixed sites
- transit operations.

In Section 70.12, common and contract carriers, freight forwarders, warehousemen, and the U.S. Postal Service are all exempt from licensing requirements. The regulations place the responsibility for transit operations on the shipper and/or the receiver of a nuclear material shipment, by stipulating that (for domestic shipments) each must be a licensee. The separation of licensing requirements into those dealing with fixed sites or transit operations allows th tional specific license requirements to be exhibited as separate.

Tables 5.1 through 5.4, below, give the interaction of the various regulations concerned with licensing. In each, a number of factors are described dealing with licensing. For the majority of items listed, several of the regulations can be considered associated with each item. Tables 5.2 and 5.4 deal with transportation. These should be interpreted as requirements over and above those for fixed sites, not as a separate set of requirements.

Tab 5.1 gives the five general areas which comprise the content of license applications for fixed sites. The five areas are: 1) purpose, 2) types of licenses, 3) information, 4) description of control and accounting procedure, and 5) description of physical security plans. At this level of detail, the general content of license applications is relatively simple and the regulations setting the content interact to support one another. As with other interactions in the regulations, a careful reading is necessary to identify the various requirements throughout the regulations.

TABLE 5.1. Content of License Application (Fixed Sites)

	Reference Code
1. Purpose and requirements: Establish procedures and criteria for the issuance of licenses for any person to 1) receive title to, 2) own, 3) acquire, 4) deliver, 5) receive, 6) possess, 7) use, 8) transfer 9) import, 10) export.	70.1 70.2 70.3 70.32(a)(8)
2. Types of licenses: General-effective without application or issuance to particular persons only for calibration or reference sources. Specific applies to all other material uses.	70.18 70.19 70.20
3. Information: 1) Name, address, age, citizenship, 3 references for person. For corporation; state, principal officer, location, control, 2) activity for which SNM requested or produced, general plan, 3) time period for license, 4) material description, 5)-6) technical qualifications and experience of staff, 7) description of equipment, and 8) procedures to protect health and minimize danger.	70.22(a) 70.24 70.59
4. Description of control and accounting procedures for SNM and fundamental material controls.	70.22(b) 70.51 70.57(b)(c) 70.58
5. Description of physical security plans for fixed sites.	70.22(h) 73.40 73.46 (proposed) 73.50 73.55 (proposed) 73.60 50.34 (c)

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TABLE 5.2. Content of License Applications - (Transport)

	Reference Code
1. Purpose and Requirements: procedures and standards for transportation and for preparation for shipment by licensee.	70.1-70.3 71.1-71.3 70.32(a)(8) 70.42 71.5
2. Types of Licenses.	
(a) General license issued to persons holding specific or general licenses who are exempt from package standards or who transport in approved containers.	71.11 71.12
(b) Specific license issued to persons holding specific licenses, for all other material transport.	71.2 71.21
3. Package description.	71.2(a) 71.22 71.25
4. Description of proposed procedural controls for inspection.	71.21(c) 71.24 71.51(c)
5. Identification of proposed fissile class.	71.21(d) 71.4(d)(e)
6. Package evaluation demonstrating that packaging will meet standards.	71.21(b) 71.23 71.31-71.42
7. Description of plan for physical protection of SNM in transit including training of guards, escorts, and special equipment designs.	70.22(g) 73.1(b)(2)(3) 73.0-73.36 73.70
8. Special information for export.	70.22(g)

The additional content of license applications for transport are given in Table 5.2. For this part of license applications, eight general areas were identified. The first, purpose and requirements, repeats the regulations shown under the same category in Table 5.1 and gives those sections of Part 71 which serve to further qualify the content for transport. Similarly, the types of licenses are separated for transport as either specific or general. The package description requirements and procedures are contained primarily in Part 71. Physical protection security plan for transport, as characterized by the seventh item in this table, are primarily in Part 73.

In Tables 5.1 and 5.2, the interactions between the regulations can be characterized as either neutral or positive. For example, in Table 5.1 information requirements are listed primarily in Section 70.22 paragraph (a). Included in this item are procedures to protect health and minimize danger. Sections 70.24 and 70.59 serve to further specify the necessary information for criticality accidents and effluent monitoring respectively.

The conditions of specific licenses are treated in much more detail than the contents of licenses. Table 5.3 lists five major categories for specific licenses at fixed sites. They are 1) license requirements, 2) issuance, 3) expiration, 4) general limitations and 5) general conditions. Here a large number of regulations could be listed as interacting. By further separating the requirements into subcategories, the apparent interactions can be reduced. The key point is that an even finer focus would further reduce the apparent interactions.

To further focus on the possible interactions, consider item 5(j) in Table 5.3 which lists tests and maintenance of material or equipment. Section 70.56 requires the licensee to perform or to permit the NRC to perform tests on a) SNM, b) facilities, c) radiation detection and monitoring instruments, or d) other equipment and devices used in connection with the production, utilization or storage of SNM. Section 73.50 paragraph (f) focuses the requirement to devices dealing with physical protection, (e.g. intrusion alarms, barriers, emergency alarms, communications, and other equipment).

TABLE 5.3. Conditions of Specific Licenses - (Fixed Sites)

	Reference Code
1. License Requirements.	70.3
(a) No person shall (1) receive title to, (2) own, (3) acquire, (4) deliver, (5) receive, (6) possess, (7) use, (8) transfer, (9) import, (10) export, except as authorized in license.	70.1(a) 70.4(h) 70.31(c)
(b) Licensee shall observe all rules, regulations and orders of the Commission.	70.32(a)(8)
2. Issuance.	
(a) Upon approval of Commission based upon determination that conditions of regulations are met and subject to limitations deemed appropriate.	70.31(a)
(b) Not issued if common defense, security, health and safety of public are endangered.	70.31(d)
3. Expiration, Renewal, Revocation.	
(a) Expiration at time specified in license except when renewal is in process.	70.32(a) 70.33(b)
(b) Renewal application should meet filing and content requirements.	70.33(a) 70.21 70.22
(c) License may be revoked, suspended, or modified for any false statement, violations, or failures to observe conditions.	70.61(b)
4. Limitations.	
(a) Rights are as defined, no transfer of rights.	70.32(a)(2),(3) 70.36
(b) All SNM is subject to recapture or control.	70.32(a)(4) 70.61(c) 70.62
(c) No SNM may be used except in accordance with the provisions in the license.	70.32(a)(5),(6)
(d) Use of material restricted to location for purposees as specified in license.	70.41(a)
(e) U.S. and Administration are not liable and make no warranty.	70.32(a)(7) 70.37
(f) Commission may incorporate in any license any additional conditions it deems appropriate.	70.32(b)
(g) No changes in material control and accounting procedures which reduce effectiveness without prior approval or ammendment.	70.32(c) 70.34

TABLE 5.3. Conditions of Specific Licenses - (Fixed Sites) (Cont'd)

(h)	No changes in physical protection plan which will reduce effectiveness without prior approval or amendment.	70.32(e) 70.22(h) 70.34
(i)	All terms and conditions are subject to amendment or modification by due process.	70.61(a)(d)
5.	Conditions.	
(a)	Possession, use and transfer of any SNM produced by a licensee in connection with or as a result of use of SNM received is subject to regulations of part 70.	70.41(b)
(b)	Maintain and follow programs for control and accounting for special nuclear material and fundamental material controls.	70.32(c) 70.22(b) 70.58
(c)	Maintain and follow programs for measurement control and accounting.	70.32(c) 70.57(b)
(d)	Follow any other material control procedures deemed essential by Commission.	70.32(c)
(e)	Provide physical protection against industrial sabotage and against theft of SNM.	73.40 73.46(proposed) 73.50 73.55(proposed) 73.60
(f)	Keep records of receipt, inventory, disposal, acquisition and transfer and status of all SNM.	70.51 70.53
(g)	Keep records of accidental criticality, loss, theft, or attempted theft of material.	70.52 73.71(b)
(h)	Allow inspection of records and facilities and document such activities.	70.55 73.70(e)
(i)	Keep records of individuals allowed access, and access controls.	73.70(a)-(d),(h) 73.46(proposed)
(j)	Perform or allow any tests of material or equipment and keep records of such activity.	70.56 73.50(h) 73.60(d) 73.70(e) 73.46(g)(proposed)
(k)	Maintain performance capabilities.	73.45(proposed) 73.55(proposed)

TABLE 5.4. Conditions of Specific License - (Transport)

	Reference Code
1. License Requirements.	
(a) Requirements for transportation and for preparation for shipment of licensed material and procedures and standards for approval by NRC of packaging and shipping procedures for fissile material.	71.1(a)
(b) No licensee shall deliver licensed materials to a carrier transfer, or transport such material without a general or specific license.	71.3 70.42(a) 71.5(a)
(c) No person shall (1) receive title to, (2) own, (3) acquire, (4) deliver, (5) receive, (6) possess, (7) use, (8) transfer, (9) import, (10) export, except as authorized in license.	70.3 70.1(a) 70.4(h) 70.31(c)
(d) Licensee who transports or delivers will do so under established procedures.	73.30(a)
(e) Preparation for shipment and transport of SNM shall be in accord with provisions in Part 71, 10 CFR.	70.41(a)
2. Issuance.	
(a) Upon approval of Commission based upon determination that conditions of regulations are met and subject to limitations deemed appropriate.	70.31(a)
(b) Not issued if common defense, security, health and safety of public are endangered.	70.31(d)
(c) Export allowed only for cooperative agreement and if interests of U.S. are protected.	70.31(e)
3. Expiration, Renewal, Revocation.	
No conditions set forth for transport as separate from specific license for fixed sites as given in Part 70, 10 CFR.	
4. Limitations.	
(a) Package and transport of materials are also subject to other parts of 10 CFR and to regulations of other agencies having jurisdiction over means of transport.	71.1(b) 71.5(a)
(b) DOT regulations are assumed to hold even when transport is not interstate or in civil aircraft.	71.5(b)
(c) DOT or postal regulations take precedance.	71.5(c)
(d) No transfer of SNM except to the (1) Administration, (2) Agency in Agreement State, (3) exempt persons, (4) exempt persons in agreement state, (5) holders of specific licenses.	70.42(a)(b)

TABLE 5.4. Conditions of Specific License - (Transport) (Cont'd)

(e)	No changes that would decrease the effectiveness of the plan for physical protection of SNM in transit.	70.32(d)
(f)	Nothing contained in the regulations in Part 70, 10 CFR authorize distribution of SNM to any person outside of U.S. jurisdiction except under terms of a cooperative agreement.	70.41(c)
(g)	Creditor must have license to take possession.	70.44
5.	Conditions.	
(a)	Possession, use, and transfer of any SNM produced by a licensee in connection with or as a result of use of SNM received is subject to regulations of Part 70.	70.41(b)
(b)	Specific licensee must verify that the transferee's license authorizes receipt of the type, form, and quantity of materials to be transferred.	70.42(c)(d)
(c)	Licensee who transfers or receives material must complete and submit material transfer reports.	70.54
(d)	Keep records of receipts, inventory, disposal, acquisition, and transfer status.	70.51 70.53
(e)	Must meet all package standards as specified and approved by the application.	71.21 71.31-71.42
(f)	Establish and maintain (1) operating procedures, (2) safe opening and closing procedures, and (3) inspection procedures.	71.51
(g)	Determine integrity of all packaging prior to each use of the package.	71.53 71.54
(h)	Maintain records for a period of two years for each shipment of fissile material.	71.62
(i)	Permit inspection and tests of materials, packaging, and premises in which material or packaging are used.	71.63
(j)	Provide physical protection by establishment and maintenance of physical protection system for SNM in transit.	73.1 73.30-73.36 73.20(proposed) 73.26(proposed) 73.46
(k)	Physical protection system performance requirements	73.25(proposed) 73.45
(l)	Notification to consignee of material transfer information	73.27(proposed) 73.72

Section 73.46 paragraph (g) supports Section 73.50 paragraph (f) above. Also listed in this category is Section 73.60 paragraph (d). This requirement parallels the requirements of Sections 73.50 and 73.46, but emphasizes physical barriers and intrusion alarms (e.g. intrusion and detection equipment). Section 73.70 paragraph (e) deals with records of testing and maintenance of physical protection devices. Of the above paragraphs, only paragraph (d) of Section 73.60 could be classified as redundant; its interaction is neutral.

Table 5.4. lists a parallel set of general conditions of licenses for transportation. Several of the criteria listed in Table 5.3 (e.g. item (a) of the first category dealing with license requirements) are repeated in this table. Others can be viewed as additional specifications for the licensing for transport of nuclear material.

By focusing on the apparent interactions dealing with the various aspects of the licensing process, selecting a variety of categories or alternative groupings, the regulations were found to interact either neutrally or in support of one another.

5.3 MATERIAL CONTROL AND ACCOUNTING

One of the major organizations used in the regulations concerned with material control and accounting is by material type, qualified by quantity. As indicated in Section 4.5, the safeguards regulations impose various levels of control dependent upon the quantity and kind of material which the licensee possesses or is authorized to use. Five points can be identified as indicative of changes in the level of control:

- any amount
- one gram
- three hundred fifty grams
- one effective kilogram
- five thousand grams.

Table 4.3 gave the specific material amounts identified in the regulations.

A second major organization is by the facility types and operations generally requiring possession or use of SNM. This was discussed as part of Section 4.4. It is important to consider possible interactions in terms of these two viewpoints.

This section compares the five material quantities above with various facilities to elicit possible contradictions in the regulations. The comparisons are based on the actual content of the requirements coupled with the material quantities actually used in facilities. Some of the results shown in Tables 5.5 through 5.7 were given in Appendix B of NUREG-0405.(a)

Recall Table 4.3 which gave all the material quantities specified by weight in the parts of 10 CFR considered in this study. In the table, the specific types of facilities to which the requirements apply are not specified. In investigating this relationship, the principal interactions were found to be in the areas dealing with the licensing process and material control and accounting requirements. With the exception of proposed Section 73.55, dealing with physical protection of power reactors, the protection requirements are founded on the facility having at least 5000 g (formula quantity) of special nuclear material.

Tables 5.5 and 5.6 below parallel Tables 5.1 and 5.3 respectively as given in Section 5.2 of this chapter. Table 5.5 compares the material quantities and facilities in the format of the content of license applications. As shown, the requirements for describing material control and accounting procedures or physical security plans are dependent upon the amount of material to be used in the facility.

Table 5.6 gives the same basic categories as were given in Table 5.3 except Table 5.6 enters only the requirements which depend on material quantities. The determination of whether or not these requirements must be met is usually dependent on a material quantity stated elsewhere as being applicable. For example, if physical protection as specified by Sections 70.22 paragraph (a), 73.20 or 73.50 is not required, then records as specified by Sections 73.70 or 73.46 are also not required.

(a) Report of the Material Control and Accounting Task Force, NUREG-0405, U.S. Nuclear Regulatory Commission, April 1978, pp. B-10-11.

TABLE 5.5. Content of License Application

Section		UO_2 Processing Plants	PUO_2 Processing Plants	Fuel Reprocessing Plants	Enrichment Plants	Power Reactors	Medical & Research Reactors	Scrap Recovery	Waste Disposal
1. Purpose & Requirements	70.1								
	70.2								
	70.3	1	1	1	1	1	1	1	1
	70.32(a)(8)								
2. Types of license	70.18	1	1	1	1	1	1	1	1
	70.19								
	70.20								
3. Information	70.22(a)	1	1	1	1	1	1	1	1
	70.24	*	*	*	*				
	70.59	1	1	1	1			1	
4. Description of control and accounting procedures	70.22(b)	4	4	4	4			4	
	70.51	4	4	4	4			4	
	70.57(b)	4	4	4	4			4	
	70.58	1	4	1	4			4	4
5. Description of physical security plan	70.22(h)	5	5	5	5			5	5
	73.20	5	5	5	5	5		5	5
	73.40								
	73.46								
	73.50	5	5	5	5			5	5
	73.55					1			
	73.60	5	5	5	5			5	5

Key (1) any amount, (2) one gram or more
(3) 350 grams (4) 1 effectively
(5) 5000 g or more
(*) 700 g U-235, 500 g U-233, 450 g Pu. See Table 4.4.

TABLE 5.6. Conditions of Licenses

Section		UO_2 Processing Plants	PUO_2 Processing Plants	Fuel Reprocessing Plants	Enrichment Plants	Power Reactors	Medical & Research Reactors	Scrap Recovery	Waste Disposal
1. Requirements	70.3	1	1	1	1	1	1	1	1
	70.31(c)	4	4	4	4			4	
2. Issuance									
3. Expiration, Renewal									
4. Limitations									
No changes in material control and accounting procedures which reduce effectiveness without approval	70.32(c)	4	4	4	4			4	
No changes in physical protection plan which will reduce effectiveness without approval	70.22(h)	5	5	5	5	5	5	5	5
5. Conditions									
Maintain and follow program for material control or accounting	70.32(c)	4	4	4	4			4	
	70.58	4	4	4	4			4	
Provide Physical Protection	70.22(h)	5	5	5	5			5	5
	73.20	5	5	5	5	5		5	5
	73.50	5	5	5	5			5	5
	73.55					1			
	73.60	5	5	5	5			5	5
Records	70.51(b)	1	1	1	1	1	1	1	1
	70.53(a)	3	3	3	3	3	3	3	
	70.52	2	2	2	2	2	2	2	

Key (1) any amount, (2) one gr[illegible] or more
(3) 350 grams (4) 1 effective kg
(5) 5000 g or more

TABLE 5.7. Material Control and Accounting

Section		UO_2 Processing Plants	PUO_2 Processing Plants	Fuel Reprocessing Plants	Enrichment Plants	Power Reactors	Medical & Research Reactors	Scrap Recovery	Waste Disposal
1. Records									
(a) Receipts, inventory, disposal, acquisition, import, export, transfer	70.51(b)	1	1	1	1	1	1	1	1
(b) Tamper-safed items: records of each such item and its identity, location, source, and disposition	70.51(e)(1)	4	4	4	4			4	
(c) Amounts added to or removed from process, amount in-process; identity, location, and quantity of unique items, and their source and identity	70.51(e)(1)(ii)	4	4	4	4			4	
(d) Material balance records	70.51(e)(4)(iii) (iv) and (v)	4	4	4	4			4	
(e) Measurement control records	70.57(b)(2) and (12)	4	4	4	4			4	
(f) Fundamental material control records	70.58(c)(2) and (g)(4) and (k)	4	4	4	4			4	
2. Material transfer									
Licensees who transfer or receive 1 gram or more must file an NRC Form 741 with NRC and with the receiver or transferrer	70.54	2	2	2	2	2	2	2	2

Key (1) any amount, (2) one gram or more
(3) 350 grams (4) 1 effective kg
(5) 5000 g or more
(a) in shielded zones,
(b) in non-shielded zones

TABLE 5.7. Material Control and Accounting (contd)

Section		UO_2 Processing Plants	PUO_2 Processing Plants	Fuel Reprocessing Plants	Enrichment Plants	Power Reactors	Medical & Research Reactors	Scrap Recovery	Waste Disposal
3. Inspections & Tests									
(a) Inspection of facilities and records	70.55(a)(b)	1	1	1	1	1	1	1	1
(b) Tests: licensees must perform or permit NRC to perform test of SNM	70.56	1	1	1	1	1	1	1	1
4. Material Status Reports									
(a) NRC-742 form to be filed in June and Dec. each year show SNM received, produced, possessed, transferred, consumed, disposed of, and lost	70.53(a)	3	3	3	3	3	3	3	
(b) MUF limits; if MUF>LEMUF and 200 g Pu, U-233, 300 g U-235 U-235>20% ENR U or 9000 g U-235 in low ENR U state reasons and intended actions. And if LEMUF exceeds applicable limits list probable reasons and planned actions	70.53(b) 70.51(e)(5)	4	4	4	4			4	
5. Procedures									
(a) Tamper-safe vaults	70.51(e)(1)(i)	4	4	4	4			4	
(b) Unique identification of items and containers	70.51(e)(1)(ii)	4	4	4	4			4	
(c) Documentation of transfer between MBAs and use of authorized signatures for control of transfer documents		4	4	4	4			4	

Key (1) any amount, (2) one gram or more
(3) 350 grams (4) 1 effective kg
(5) 5000 g or more
(a) in shielded zones,
(b) in non-shielded zones

TABLE 5.7. Material Control and Accounting (contd)

Section		UO_2 Processing Plants	PUO_2 Processing Plants	Fuel Reprocessing Plants	Enrichment Plants	Power Reactors	Medical & Research Reactors	Scrap Recovery	Waste Disposal
6. Inventory									
(a) Every 12 months	70.51(d)	3	3	3	3	3	3	3	3
(b) Every 2 months	70.51(e)(3)(i)			4[a]				4	
(c) Every 6 months	70.51(e)(3)(ii)			4[b]				4	
(d) Inventories must be in accordance with 70.51(e) and within 30 days after start of each ending inventory	70.51(e)(3) 70.51(f) 70.51(e)(4)	4	4	4	4			4	
(i) calculate MUF and LEMUF	70.51(e)(4)(i)	4	4	4	4			4	
(ii) reconcile and adjust book record	70.51(e)(4)(ii)	4	4	4	4			4	
(iii) complete and maintain records as in IV(a)1,2,3 and 4 above	70.51(e)(4)(ii) (iv) and (v)			4					
7. Limits on LEMUF									
(a) 1% of total inprocess material balance for Pu or U-233 in reprocessing plants or	70.51(e)(ii)			4					
(b) 0.7% of total inprocess material balance for U element and fissile isotope or	70.51(e)(ii)			4					
(c) 0.5% of total inprocess material balance for Pu, U-235 or high-enriched U element and fissile isotope	70.51(e)(5)(ii)	4	4		4				
(d) 0.5% of total inprocess material balance of low enriched U element and fissile isotope or	70.51(e)(5)(ii)	4	4		4				
(e) Other limits as approved by NRC	70.51(e)(6)	4	4	4	4				

Key (1) any amount, (2) one gram or more
(3) 350 grams (4) 1 effective kg
(5) 5000 g or more
(a) in shielded zones,
(b) in non-shielded zones

Table 5.7 details material control and accounting requirements. Most of the requirements are in effect at the one effective kilogram level. This table serves to link the principal material control and accounting requirements and exhibit their interactions. It also indicates their applicability to certain facilities which is difficult to ascertain from the regulations. General observations regarding the interactions of material control and facilities are:

- *A number of the requirements have implicit rather than the explicit material quantities. Similarly, the relations between the quantities and facilities are not readily apparent.*
- *Relating material quantities specified in the regulations with specific facilities substantiates the various levels of control identified as preface to this section and in Section 4.6 of this report.*
- *There do not appear to be any negative interactions in relations between material quantities and the facilities governed by the regulations. The majority can be classified as neutral.*

5.4 PHYSICAL PROTECTION

This section briefly addresses the interactions within the physical protection requirements which are contained mainly in Part 73, Physical Protection of Plants and Materials, of Chapter 10 CFR. The majority of the interactions within this category have already been identified by the classifications presented in Chapter 4 of this report.

To show a precedence relationship between regulations, the interactions between the principal transit physical protection requirements were given by Figure 5.1 in the first section of this chapter. Figure 5.2 exhibits a similar relationship for the requirements dealing with facilities (fixed sites).

The relation shown in Figure 5.2 gives an orientation to viewing the physical protection requirements from a performance perspective. On this basis Section 73.20 of the proposed upgrade rules is shown at the top of the hierarchy. An alternative presentation would exhibit Section 73.40 as the principal requirement because it establishes the fact that the licensee must provide physical protection.

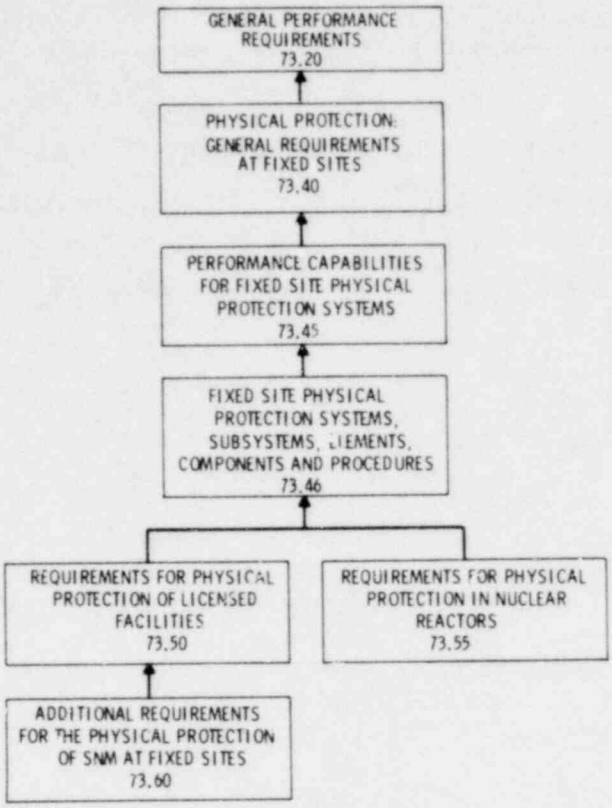

FIGURE 5.2. Precedence Among Fixed Site Physical Protection Requirements

Figures 5.1 and 5.2 are of additional interest because they exhibit an interaction of the proposed upgrade rules. Within both the current requirements and the upgrades the regulations provide references to other sections which each support. In Figure 5.1, Section 73.26 is intended to supplant 73.30 through 73.36. Similarly, Section 73.46 shown in Figure 5.2 supercedes Sections 73.50 and 73.60.

Another separation of the regulations is between physical protection of SNM and physical protection of facilities themselves; e.g., not specifically dealing with material. Such a separation is more subtle than actual. A closer look at the requirements in Figure 5.2 shows that all of the section titles except Section 73.60 make no reference to material. They are, however, applicable only if the facility contains a quantity of material (except 73.55) exceeding a formula quantity. Section 73.40 does make a distinction between the acts of industrial sabotage and theft of special nuclear material.

Similarly, Section 73.20 again makes the distinction in promulgating general performance requirements. The purpose of the separation between physical protection of facilities and of SNM is to differentiate the consequences between sabotage and theft.

Further interactions among the physical protection requirements can be investigated by comparing the classification of the regulations content with the various categories used in the requirements.

Sections 73.46, 73.50, and 73.55 all give a set of categories by which the various paragraphs of their contents are grouped. Table 5.8 lists the major headings of each section. As can be seen, the major paragraph headings exhibit a parallel organization. The two proposed upgrades, Section 73.46 and 73.55, exhibit the most similarity. This includes, in most cases, referencing the same elements, which can be substantiated in the fact that the two sections usually appeared together in the classifications of Chapter 4. Similarly,

TABLE 5.8. Categories Used in the Fixed Site Physical Protection Requirements

Section		
73.46	73.50	73.55
Fixed Site Physical Protection Systems, Subsystems, Elements...	Requirements for Physical Protection of Licensed Activities	Requirements for Physical Protection of Licensed Activities (Power Reactors)
Paragraph		
(b) Security organization	(a) Physical security organization	(b) Physical security organization
(c) Physical barrier subsystems	(b) Physical barriers	(c) Physical barrier subsystems
(d) Access control subsystems and procedures	(c) Access requirements	(d) Access requirements
(e) Detection, surveillance and alarm subsystems and procedures	(d) Detection aids	(e) Detection aids
(f) Communications subsystems	(e) Communications requirements	(f) Communications requirements
(g) Test and Maintenance programs	(f) Testing and maintenance	(g) Testing and maintenance
(h) Contingency and and response plans and procedures	(g) Response requirement	(h) Response requirement

Section 73.50 also was classified in conjunction with the two proposed requirements. No major contradictions or conflicts regarding compliance can be identified.

A similar comparison can be made for the transit physical protection requirements. Proposed Section 43.26 - Transportation Physical Protection Systems, Subsystems, Elements Components, and Procedures - parallels the organization of several of the sections in the current regulations. These interactions are shown in Table 5.9. As shown, the requirements in Section 73.26 are clear upgrades over current requirements. Notable are increased guards/escorts and prior arrangements for assistance.

TABLE 5.9. Categories Used in the Transit Physical Protection Requirements

Section	
73.26	
Transportation Physical Protection Systems, Subsystems, Elements, Components, and Procedures	Current Transportation Physical Protection Requirements
Paragraph	
(a) General requirement for transportation physical protection	73.30(a) general requirement
(b) Planning and scheduling	
(1) avoid regularity and high risk areas, transit times	73.30(b)
(2) prior arrangements with LLEAS	
(3) series of small shipments	
(4) NRC prior approval	73.30(f)
(c) Export/import shipments	73.32(c) export of air 73.34(c) export of sea 73.36(b) import shipments
73.26	
Transportation Physical Protection Systems, Subsystems, Elements, Components, and Procedures	Current Transportation Physical Protection Requirements
Paragraph	
(d) Security Organization	73.30(d) guard's qualifications
(e) Contingency and response plans	
(f) Transfer and storage of SSNM for domestic shipments	73.35 Transfer of SNM
(g) Access control subsystems and procedures	
(h) Test and maintenance programs	
(i) Shipment by road	73.31 Shipment by road
(j) Shipment by air	73.32 Shipment by air
(k) Shipment by rail	73.33 Shipment by rail
(l) Shipment by sea	73.34 Shipment by sea

The next area of possible interactions among the physical protection requirements deals with specific elements covered by two or more of the regulations. The methodology exercised in Chapter 4 to classify content was used for this purpose. All regulations dealing with a specific element, were reviewed in detail for each base. Again, for the purpose of identifying possible interactions from the perspective of physical protection, elements were pairwise compared between the regulations. No major conflicts in the form of negative interactions were identified.

To summarize:

- *Physical protection is naturally separated in the regulations between transportation and fixed sites; however, a separation between protecting facilities and protecting material in facilities can also be made.*
- *The proposed upgrade rules for Part 73 present the majority of interactions in the area of physical protection; these interactions can be viewed as a set of precedence relations representing positive interactions.*

5.5 GENERAL OBSERVATIONS

This section discusses several additional factors regarding the interaction of the various safeguards regulations. First, the method is used to identify those elements not covered in the regulations. Such an identification could help clarify the interaction of future improvements in the current regulations. This is exhibited by considering the proposed physical protection upgrades for Part 73.

Next an additional set of interactions related to the structure of the regulations are presented. These are the references to other sections made by various sections. From a structural viewpoint, the references represent an additional set of interactions.

Elements Not Covered

In Chapter 4, the regulations were classified with respect to their content within a number of organizational categories or bases. The classification represented a first-level set of interactions requiring further focus to determine possible conflicts or contradictions.

The methodology also identifies elements not covered by a given requirement. Lack of coverage also indicates the scope of a requirement and its dependence on other sections for proper interpretation.

However, the process of developing a taxonomy that classifies the contents and various concerns of the safeguards regulations was described in the second chapter as an iterative process. The proper selection of elements, and even the appropriate bases, can only be achieved by conducting the classification. Hence, elements not covered may either serve to indicate gaps in the regulations or they may be unnecessary. Here, the elements not covered are presented and those representing possible gaps in coverage are identified.

Figures 5.3 and 5.4 present, for Parts 70, and 73 respectively, the elements not identified as covered in the review of the regulations. Figure 5.5 presents the same results for the proposed upgrade rules in Part 73. This latter figure is given separately to display the interactions of the proposed sections with those currently in Chapter 10 CFR. *In each of the three figures, unlike the figures in Chapter 4, the elements not covered are shown as marked in black.*

Figure 5.3 shows, for the forty sections contained in Part 70, elements that were considered not covered by any of the sections. It represents no major surprises regarding possible gaps in coverage. In the figure, three bases are shown as not covered by any of the sections of this part; they are, Base 13 - Access Control, Base 16 - Response, and Base 30 - Adversary characteristics. Each of these are normally considered to be within the realm of physical protection. Notice also that there are no gaps in Base 23 - Accounting, one of the primary concerns of this part. In Base 9, strategic special nuclear material is not referenced, indicating new terminology and similarly material measures commonly associated with packaging are not mentioned. General areas not covered are specific references to equipment and functions related to physical protection.

ELEMENTS NOT COVERED IN THIS PART

1. REGULATORY REQUIREMENT
2. REGULATORY ACTIVITY
3. DESIGNATED RESPONSIBLE PARTY
4. SAFEGUARDS INTENTS
5. FACILITY TYPE
6. OPERATION - FIXED SITE
7. OPERATION - TRANSIT
8. TIME PHASE OF FACILITY
9. MATERIAL TYPE CLASSIFICATION
10. ELEMENTAL FORMS
11. MATERIAL MEASURES
12. SAFEGUARDS PERFORMANCE CRITERIA
13. ACCESS CONTROL
14. SURVEILLANCE
15. INVESTIGATION
16. RESPONSE TO SECURITY CONTINGENCIES
17. PLANNING - DESIGN
18. RECORDS AND REPORTS
19. DETERRENCE
20. ASSURANCE
21. COMMUNICATIONS
22. SECURITY ORGANIZATION
23. ACCOUNTING
24. INTRUSION AND DETECTION DEVICES
25. ALARM AND COMMUNICATION SYSTEM
26. SECURITY AREAS
27. ARMAMENT, PROTECTION EQUIPMENT
28. OTHER SAFEGUARDS EQUIPMENT
29. LOCATION IN SAFEGUARDS SYSTEM
30. ADVERSARY CHARACTERISTICS
31. ADVERSARY ACTION MODE
32. STAGE OF ADVERSARY ACTION
33. CONSEQUENCE REDUCTION

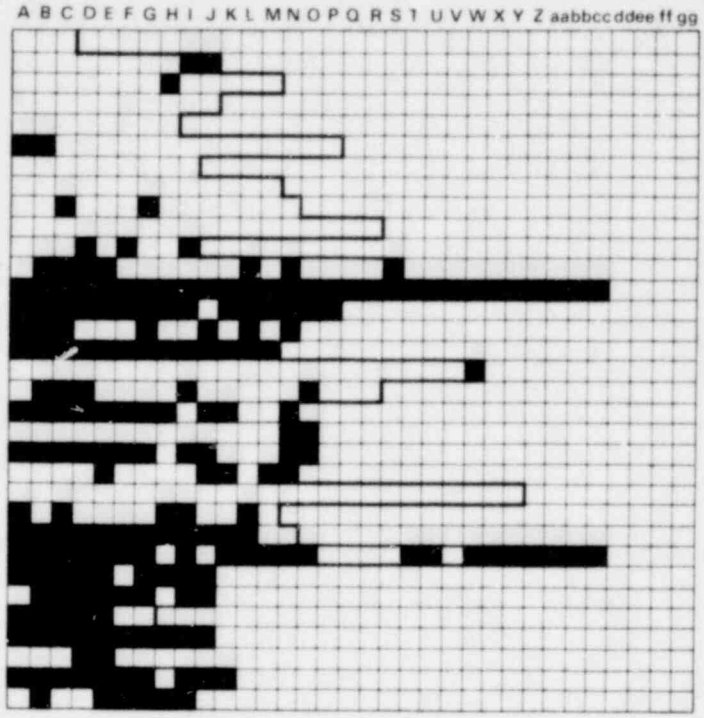

FIGURE 5.3. Part 70 - Special Nuclear Material

ELEMENTS NOT COVERED IN THIS PART

1. REGULATORY REQUIREMENT
2. REGULATORY ACTIVITY
3. DESIGNATED RESPONSIBLE PARTY
4. SAFEGUARDS INTENTS
5. FACILITY TYPE
6. OPERATION - FIXED SITE
7. OPERATION - TRANSIT
8. TIME PHASE OF FACILITY
9. MATERIAL TYPE CLASSIFICATION
10. ELEMENTAL FORMS
11. MATERIAL MEASURES
12. SAFEGUARDS PERFORMANCE CRITERIA
13. ACCESS CONTROL
14. SURVEILLANCE
15. INVESTIGATION
16. RESPONSE TO SECURITY CONTINGENCIES
17. PLANNING - DESIGN
18. RECORDS AND REPORTS
19. DETERRENCE
20. ASSURANCE
21. COMMUNICATIONS
22. SECURITY ORGANIZATION
23. ACCOUNTING
24. INTRUSION AND DETECTION DEVICES
25. ALARM AND COMMUNICATION SYSTEM
26. SECURITY AREAS
27. ARMAMENT, PROTECTION EQUIPMENT
28. OTHER SAFEGUARDS EQUIPMENT
29. LOCATION IN SAFEGUARDS SYSTEM
30. ADVERSARY CHARACTERISTICS
31. ADVERSARY ACTION MODE
32. STAGE OF ADVERSARY ACTION
33. CONSEQUENCE REDUCTION

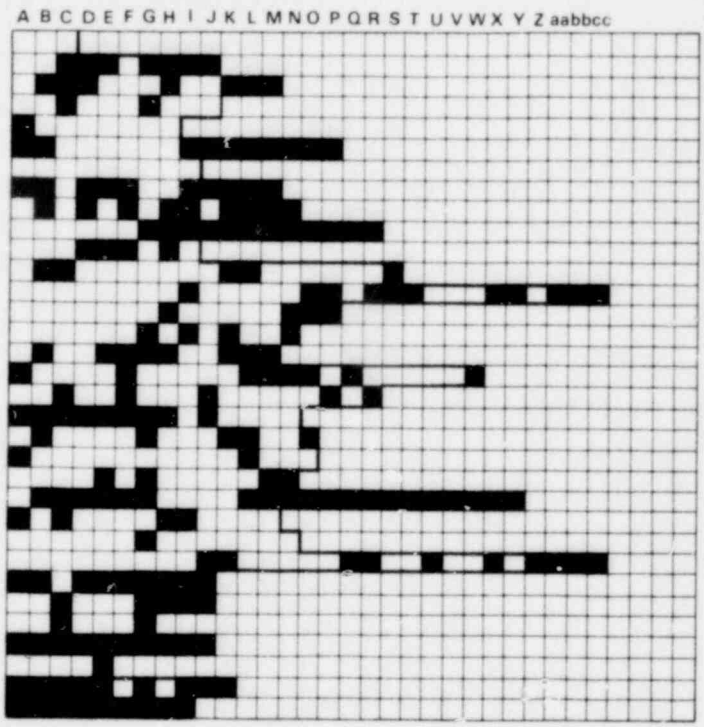

FIGURE 5.4. Part 73 - Physical Protection of Plants and Materials

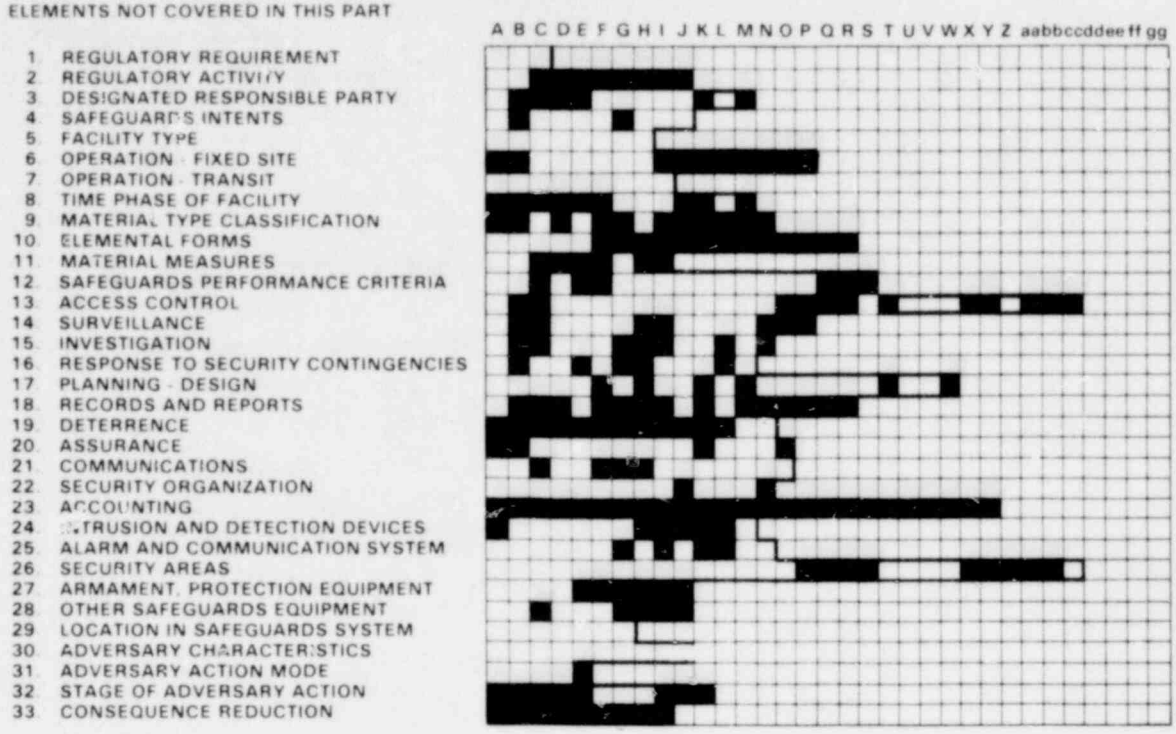

FIGURE 5.5. Part 73 (Proposed Upgrades) - Physical Protection of Plants and Materials

Figures 5.4 and 5.5 indicate elements not covered in the context of the physical protection requirements of Part 73 and the proposed upgrades to that Part respectively. As can be seen by the figures, major areas not covered are accounting (Base 23) and materials other than special nuclear material.

It is interesting to compare Figures 5.4 and 5.5 to identify areas that are afforded coverage in the proposed upgrades. Several specific elements covered in the proposed upgrades, and not in the current requirements are worth noting. They are:

Base 6 - Facility type - power reactors are to be protected

Base 8 - Time Phase - maintenance and alarm situations are considered

Base 12 - Performance criteria - continuous knowledge (visual surveillance), natural wariness

Base 13 - Access Control - badge display and scheduling

Base 15 - Investigation - investigate threat

Base 16 - Response - assessment of threat,

Base 17 - Planning - Design - postulated threat, weapons, security equipment, responsibilities

Base 20 - Assurance - program audit, provisions

Base 21 - Communications - common language, specifications

Base 22 - Security Organization - screening, tests, capabilities

Base 30 - Adversary Characteristics - all elements

The various elements indicate the general concern and flavor of the proposed rules with respect to the increase in coverage they provide.

The above demonstration indicates the potential utility of the methodology in determining the interactions of new regulatory improvements. Of course, caution must be taken in dealing with specifics. The classifications given in Chapter 4 and to a degree, summarized by Tables 5.3 through 5.6, serve as a general guide. A careful examination of the actual structure and contents is necessary, particularly in seeking gaps or overlaps, because of the subjective decisions used in classifying the regulation contents.

References to Other Sections

The last area examined for possible contradictions is the references contained in the various sections to other sections, other Parts of Chapter 10, or other Chapters of the Code of Federal Regulations. The structure exhibited by these references is indeed complex, lending to possible confusion in interpreting the requirements.

Figures 5.6 and 5.7 exhibit in flow diagrams the references contained in Parts 70 and 73 respectively. The interactions are shown at the paragraph level in block diagram fashion. For example, if paragraph 70.19(a) refers to paragraph 70.4(f), as depicted in Figure 5.6, then each is shown as a separate block in the figure. A specific Section, e.g. 70.19, is shown as a block

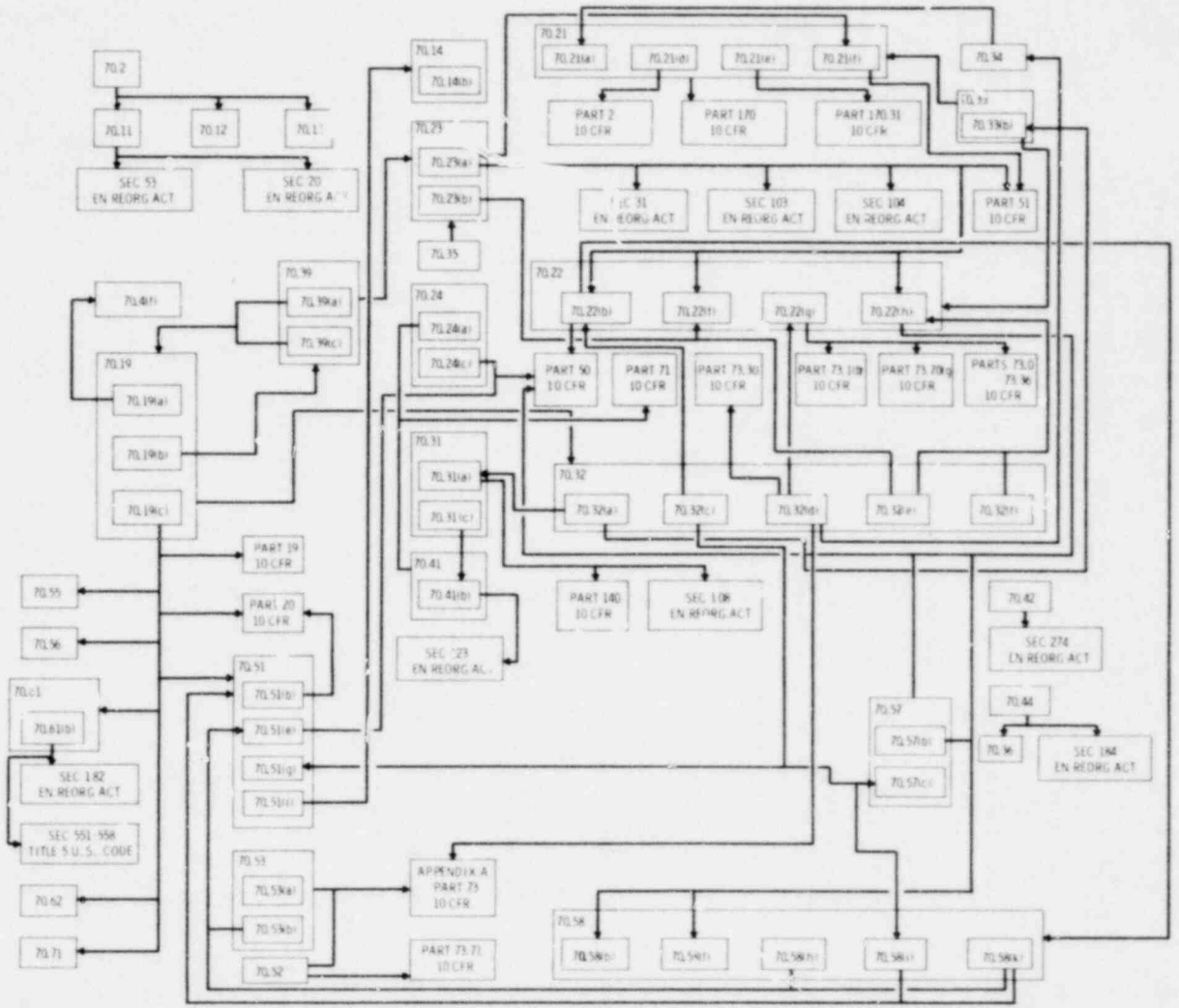

FIGURE 5.6. References to Other Sections - Part 70

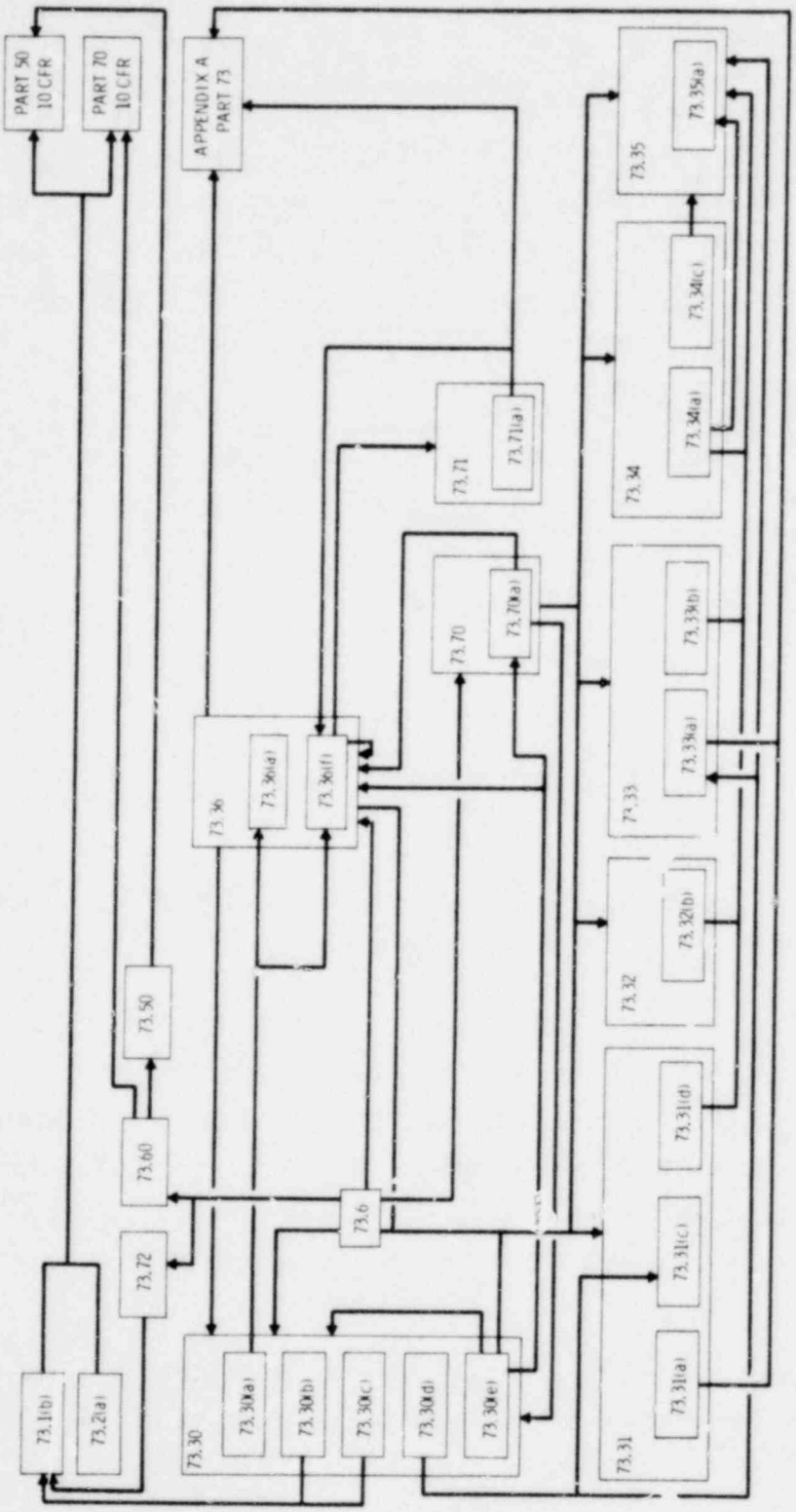

FIGURE 5.7. References to Other Sections - Part 73

surrounding its paragraphs. Paragraphs can also refer to sections as a whole, e.g., paragraph 70.39(a) refers to Section 70.19, and Sections can refer to Sections, e.g., 70.39 to 70.23.

The major interactions within each of the parts are among the various sections in that part. Part 70 shown in Figure 5.6 also refers to Parts 50, 51, 70 and 73 of 10 CFR as well as several sections of the Energy Reorganization Act. The links between Parts 70 and 73 are from the licensing requirements in Sections 70.22 and 70.32 and back via the general physical protection requirements of Sections 73.1, 73.2, 73.50 and 73.60. Note in Figure 5.7 the interesting reference in paragraph 73.36(f) to its own Section.

The references within and outside the proposed upgrades for Part 73 are not shown in Figure 5.7. As with the parts shown, the proposed rules are linked among themselves and back to the current Part 73. The current references in Part 73 are also under proposed amendment to include reference to the new requirements.

In general, there are few linkages in Figures 5.6 and 5.7 that have not been exhibited elsewhere in this document. The majority of the references link some specific area of concern within the requirements. The structure shown in the two figures is difficult to follow because starting points are not readily identified. It does, however, provide a good source to follow the interactions as given explicitly by the regulations.

Summary

In Chapter 4 the content of the regulations was classified in several categories. These categories or bases each contained a number of associated elements or terms. If in reviewing the content of a given Section, an element of a base was deemed applicable, then that element was "checked-off". Each section was reviewed in this manner, creating an information file which characterized the regulations' contents.

Although highly detailed, as merited by the commensurate detail of the safeguards regulations themselves, the classifications of Chapter 4 only

indicated a set of interactions requiring further investigation. This chapter has investigated the major interactions, seeking inconsistencies and possible contradictions.

Each of the major areas of interactions (the licensing process, material control and facilities, and physical protection) were viewed in more detail. Two other areas of potential interaction, gaps in coverage and references to other parts, were also considered.

Focusing has shown that:

- *The regulations are complex and interact in both obvious and subtle manners; as a whole the interactions are either neutral or positive.*

6.0 STRUCTURES

This chapter considers the structure of the safeguards regulations. To a certain extent, the structure of the regulations has already been presented. The classifying categories and the resultant classifications identified in the previous sections reflect the structure of the regulations' contents.

A structure's purpose is to display the organization and content of the regulations. A structure allows the reader to readily identify those regulations that deal with his specific area of focus. The direction taken in the study was to analyze the regulations from a variety of perspectives to discover whether all aspects of that perspective are covered in the regulations. The classifying methodology developed for this purpose allows representation of the regulations' contents in a variety of ways.

This chapter ties together the various perspectives that may be used to view the contents of the regulations. The first section discusses a number of ways to view the contents of the regulations. The following sections focus on the representation of the regulation's structure.

6.1 CREATING STRUCTURES

In developing the taxonomy for the safeguards regulations, an attempt was made to account for the various ways their contents may be organized. This consideration was kept in mind in the selection of bases and their respective elements. In Chapter 2, which describes the methodology, this accounting was referred to as "creating structures."

Certain of the bases are necessary parts of any representation of the regulations' structure. Some of these - for example, the designation of responsibility to licensees, contractors, or the NRC - are required by law. Others are dependent on the attributes of the physical systems being regulated; for example, all of the facilities or operations considered are distinguished by the presence of nuclear material.

Other bases used in classifying the regulations, such as those dealing with intents, adversaries, or general performance requirements represent possible alternative concerns regarding the regulations' contents. These perspectives are not major factors in considering the regulations as a whole, but they are an important part of their structure.

Ten major perspectives were identified as possible ways to view the contents of the regulations. These were incorporated in the selection of the bases for classifying the regulations. By viewing the regulations with each perspective, insight into their organizational structure can be gained. The major perspectives are:

- Performance - identifying those regulations for which exhibiting performance or meeting certain criteria is necessary for compliance.
- Procedures - viewing the various procedures spelled out in the regulations as being analytical, technical, or administrative.
- Policy Responsiveness - considering the regulations in terms of their form, generality or liability target.
- Threat - characterizing the regulations from a "risk" viewpoint in terms of possible acts and their consequences to society.
- Activity Direction - separating the regulations as those dealing with people and those dealing with things.
- Function - taking each of the functions that characterize safeguards activity as a perspective.
- Strategy - separating the requirements along traditional lines of material control or physical protection.
- Location - viewing the regulations as either dealing with fixed sites or transportation activities.
- Facilities and Materials - classifiying the regulations by facility and associated material type.

- Equipment and Security Areas - focusing on the physical systems of equipment required by the regulations.

The following are observations about the regulations' structure from each of the above perspectives:

Performance. The design of performance-based regulations is a major concern in the NRC. A number of the current regulations can be liberally interpreted as dealing with some aspect of performance. The difficulty in addressing this concept is primarily founded in the inherent problem of measuring performance. The difficulty was indicated in the process of classifying the regulations as related to performance.

There are no particularly valid criteria given in the regulations by which performance can be measured. The regulations use general expressions such as "prevent with high assurance" or "protect" to characterize general performance and terms such as "comply with design criteria" or "demonstrate effectiveness" for specific performance requirements.

Obviously the regulations would become encumbered if specific performance criteria were detailed for each requirement. However, it would be desirable to define a general set of criteria which the licensee could use to interpret the meaning of the performance in order to exhibit compliance. Viewing the regulations from the perspective of performance, e.g., where it is necessary for the licensee to exhibit performance, would aid all concerned parties in the proper interpretation of the requirement.

Procedures. The regulations specify a number of procedural requirements. These can be grouped as analytical, technical, or administrative. Analytical procedures appear primarily in the context of the material control and accounting requirements of Part 70. Technical procedures, as used herein, deal with activities or functions such as operation of the communications system, patrol duties, and so forth. Procedures such as recordkeeping, filing of reports, or management of the security organization are primarily administrative.

The licensee usually has an organizational structure which is related to procedures. By taking such a perspective on the requirements by procedures, it is possible to designate those requirements that need be met by

various personnel. For example, the security organization need not be concerned with material accounting as long as no specific acts are indicated.

Policy Responsiveness. The requirements promulgated by the regulations take on various forms and differing degrees of generality. This perspective deals with the relating of the overall goals or objectives of a given regulation to the scope of the requirement. In other words, how should the requirement meet its objective in terms of specifying activities, functions, or objects? This perspective is important to the NRC.

The responsiveness of a regulation to safeguards policy is based on three related decisions:

- What is the goal or objective of the requirement?
- What is the scope of the requirement?
- What function, activities, or objects are within the scope of the requirement?

In determining the content of the regulations, each of the above three questions may be asked. Answers for all three may be difficult to establish. To some extent this viewpoint is related to the characterization of a regulation as being goal, performance, or procedural. A goal requirement only answers the first question. A procedural requirement provides scope but not necessarily the functions or objects giving adequate compliance. Procedural requirements deal with the third question.

It is also sometimes difficult to determine the goal for a given set of procedures or specifications. This difficulty is perhaps given focus by considering the generality of a requirement from this perspective. For example a number of the requirements deal with specific "subsystems, components, or elements" of the safeguards system. For example, they may designate regular communications between shipment escorts and a movement control center or they may further elaborate by requiring a radiotelephone device.

Threat. The perspective of viewing the regulations in terms of the possible threats that would compromise the safeguards system reflects a risk orientation. A number of the current effectiveness evaluation methodologies take this viewpoint.

In this context, several possible adversary groups could be defined and related to the kinds of acts that could be taken against facilities or transit operations. The regulations could be classified in terms of the types of actions they are intended to thwart. Similarly, the characterization of the probability of a possible act in proportion to the consequence of its success provides a measure of the importance of a given requirement. This viewpoint is one approach to identify if the regulations do indeed provide protection against all contingencies.

Activity Direction. It is possible to classify those regulations that deal with people and those which specify devices or physical systems necessary for the various safeguards activites. This separation helps determine the interrelationships between the personnel and the equipment they utilize in performing safeguards activites. This separation is not common in the regulations. By taking this perspective, the specific equipment can be directly related to the personnel who must operate it.

Function. One viewpoint is to characterize a set of functions that are necessary for the overall safeguards activity. The classification process used in this report has shown one example set of possible safeguards functions. This is a traditional viewpoint often used to characterize safeguards systems or their various attributes. This perspective is important in considering possible gaps within the regulations in terms of the safeguards system they define. By separating the various functions, the interrelationships between functions can also be elicited to a certain extent.

Strategy. A delineation of the regulations by strategy is traditional and one of the major organizational formats taken by the safeguards regulations--that is, a separation between material control and accounting or physical protection. An alternative viewpoint, also exhibited by the regulations, further separates material control and material accounting into two respective groupings. A third possibility is to separate the protection of materials from the protection of facilities. Each of these viewpoints has been touched upon elsewhere in this report.

This general perspective remains important in any of its manifestations mentioned above. The perspective, here called strategy, is sometimes also referred to as a safeguards function. Here, the view is taken that each function serves one or both of the strategies. For example the function of access control may serve to protect from clandestine theft of material.

Location. The safeguards regulations specify different protective and control measures that are both dependent on the type of material and its amount, and whether the material is within a facility or in transit between facilities. An organization of those regulations concerned with fixed sites and those dealing with transportation is made in the regulations, particularly in Part 73 dealing with physical protection.

This perspective is important in relating the level of control or protection specified by the requirement to the material's location.

Facilties and Materials. It is also possible to classify the regulations in terms of the facilities and the material types or quantities with which they deal. The regulations are somewhat structured in terms of material quantities but their interaction with specific facility types or operations is not specified well in context.

Equipment and Security Areas. The regulations can also be viewed in terms of the specific equipment or subsystems of components required by the regulations. The activity direction perspective discussed above separated the requirement into those dealing with people and those dealing with objects or things. This perspective further divides the objects into identifiable parts.

Whereas the procedural perspective identifies a separation into the types of activities that people conduct, this perspective separates the systems or components to which procedures are directed.

The various structural perspectives summarize a number of possible viewpoints that can be used to categorize and structure the regulations. In effect, the various viewpoints interact with one another. For example, the procedures

and application perspectives can be used in support of the activity direction perspective. The former separates what people do, the latter separates groups of objects as specific subsystems or components.

Figure 6.1 depicts a second set of interactions among the structural perspectives. In the figure, two structural perspectives are combined and interactions among the two are shown - location and safeguards strategy. The interactions are shown as cells in the matrix. The majority of structural representations of the safeguards regulations combine several perspectives.

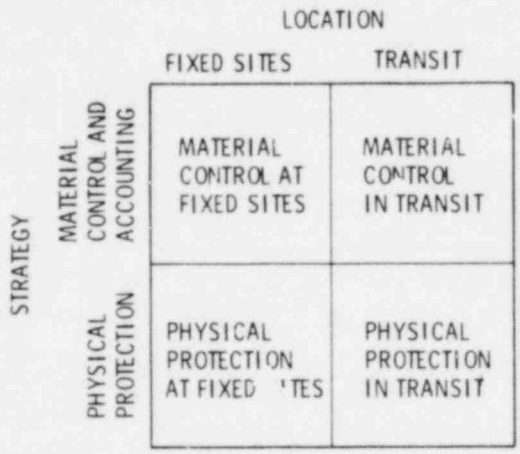

FIGURE 6.1. Combining Structural Perspectives

The relationships between the bases used for classifying the regulations and each structural perspective discussed above are shown in Figure 6.2. The actual process of determining and defining the bases took account of the perspectives and their potential for representing the structure of the regulations. In the figure, the applicable bases are marked as related to specific perspectives.

6.2 A STRUCTURE FOR THE CLASSIFYING METHODOLOGY

The bases and elements used to classify the safeguards regulations can be organized by structural perspectives to represent a number of interrelationships. In this section, the structural perspectives and their associated bases (given in Figure 6.2) are related. The approach follows that of Chapter 2 which presented the methodology.

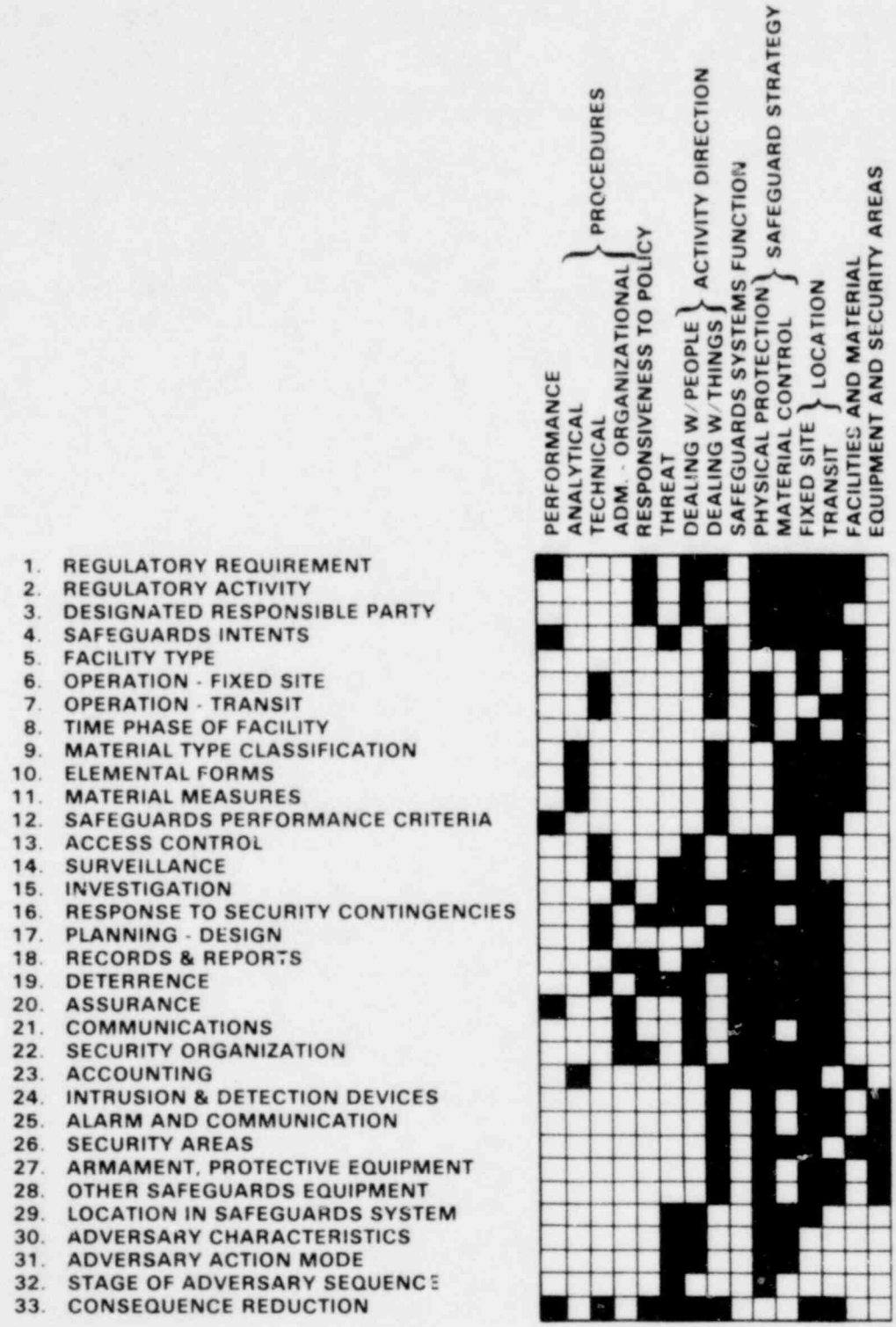

FIGURE 6.2. Relating the Bases to the Structural Perspectives

The important aspect here is not so much the representations themselves, but the regulations that are associated with each perspective. Since each regulation has been classified by content in terms of the bases and their elements, the methodology allows an identification of specific sections of the regulation as part of each example structure presented. Because the regulations have already been associated with each particular base and element, the presentation of this section is not complicated by repeating the classifications.

Performance. In Figure 6.2 of the previous section, five bases were identified as dealing with performance. Following the methodology given in Chapter 2, an example set of objective statements which characterize this perspective could be given as:

- To specify regulatory requirements as performance requirements, the output and level of achievement required must be given.
- To specify performance, requirements must establish intents.
- To measure performance, performance criteria are necessary.
- To provide assurance, to the NRC and to the public, is an intent of performance requirements.
- To reduce consequences to the public is an intent of performance requirements.

The five objective statements dealing with performance are written in the general form as given in Chapter 2. The statements can be associated with five specific bases:

ase 1 - Regulatory Requirement
Base 4 - Intents
Base 12 - Performance Criteria
Base 20 - Assurance
Base 33 - Consequence Reduction

For this example the five objective statements are given in the same order as the numbers of the bases. Given a set of objective statements, the elements of the relevant bases are compared to determine precedence and subordination relations. This is given as the fourth step in Section 2.3 which summarized the methodology.

For this example, the structural perspective is performance. Hence, the first objective statement takes the highest precedence. The remaining four objective statements' order must be established on a subjective basis. In deference to the hierarchy of structure shown in Figure 2.2, it is assumed that the intents of the requirement serve to direct the objective to activities. By this reasoning, Base 1 - Regulatory Requirement takes precedence over Base 4 - Safeguards Intents.

Figure 6.3 shows the basic hierarchal intents structure as defined in the methodology. For this perspective, only three elements are shown from the five bases depicted. In the block labeled "BASE 4 OTHER ELEMENTS", shown to the right in Figure 6.3, the other intents elements related to performance could be listed. Several other elements such as prevention, deterrence, etc. could be interpreted as within the scope of performance requirements.

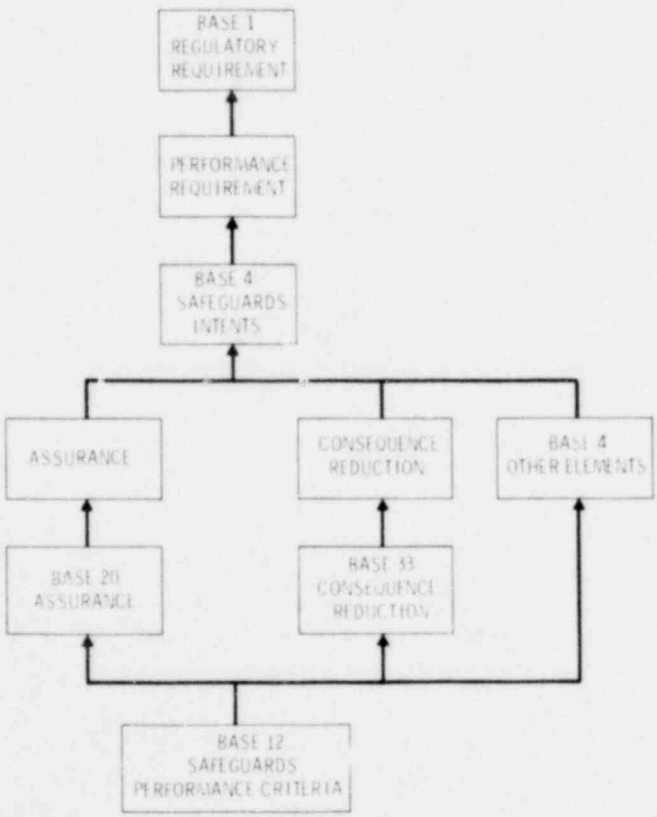

FIGURE 6.3. Performance Perspective

This first example, dealing with the perspective of performance, has followed the methodology. This is, in part, to exhibit its application for the development of structures. The following presentation for the remaining structural perspectives is more informal. The reader should keep in mind, while reviewing the various structures, that there is no unique way to depict structure. As there are other viewpoints for interpreting the regulations, there are alternative representations within a given structural perspective. Similarly, there are other elements that could be included or deleted from each structure.

Procedures. Figure 6.4 depicts the structural perspective that separates procedural requirements as being analytical, technical, or administrative. Although not shown at the top of the hierarchy, the first base - Regulatory Requirement - could be shown as the key objective. This base separates the requirements as being goal, performance, or procedural in orientation. The regulations that are associated with this structure are those classified as procedural.

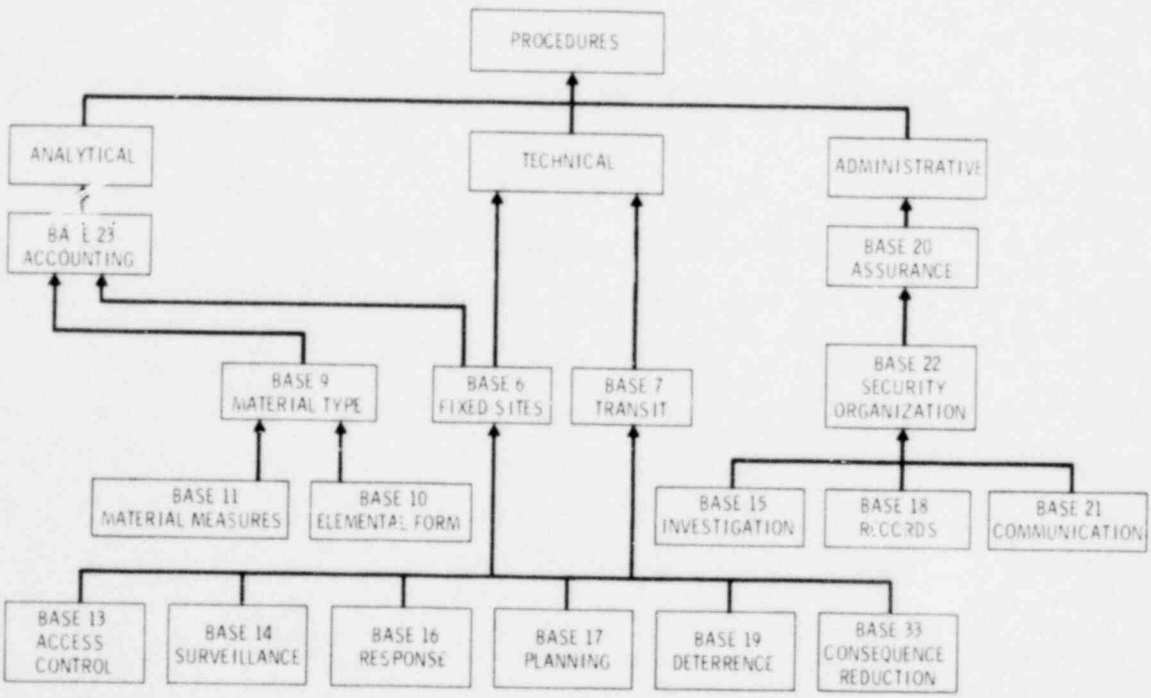

FIGURE 6.4. Procedural Perspective

A general objective statement for the structure shown in Figure 6.4 could be:

- To view procedural requirements as being either analytical, technical, or administrative.

Here, procedural requirements are primarily concerned with bases that are referred to as "functions of the safeguards system". These are Bases 13-23 and 33. Also included are Bases 6 and 7 dealing with operations as either fixed or transit respectively, and Bases 9-11 dealing with material. The second set of bases is directly related to the structural perspective which was referred to as "location". The third set, dealing with material, is common within the organization of the regulations.

The groupings of the various bases shown in Figure 6.4 represent several precedence relationships that might be interpreted in different ways. For example it is shown that the security organization supports assurance in an administrative manner. Of course, the security organization also conducts the various safeguards functions. Similarly, there are a number of administrative procedures necessary for the conduct of the various functions identified as technical.

Responsiveness to Policy. This perspective considers the regulations in terms of their form, generality, or liability target. The jurisdictional questions regarding response, deterrence (e.g. information disclosure or restriction), the authority of the security organization, and measures to reduce possible consequences are all part of this perspective.

Figure 6.5 displays the structure depicting the responsiveness to policy perspective. As shown, the principal concern is the form of the regulatory requirements. This is shown as dependent on the type of regulatory activity. The key elements of Base 2 dealing with regulatory activity are shown as licensing, rule making, inspection and enforcement. The requirement is directed for each activity to a designated party, usually the licensee. Licensee employees, in turn, conduct various activities such as response, record keeping or procedures to reduce consequences or provide deterrence. Here, again, one could argue for the inclusion of all the safeguard functions since they are all conducted pursuant to the legal requirements of the regulations.

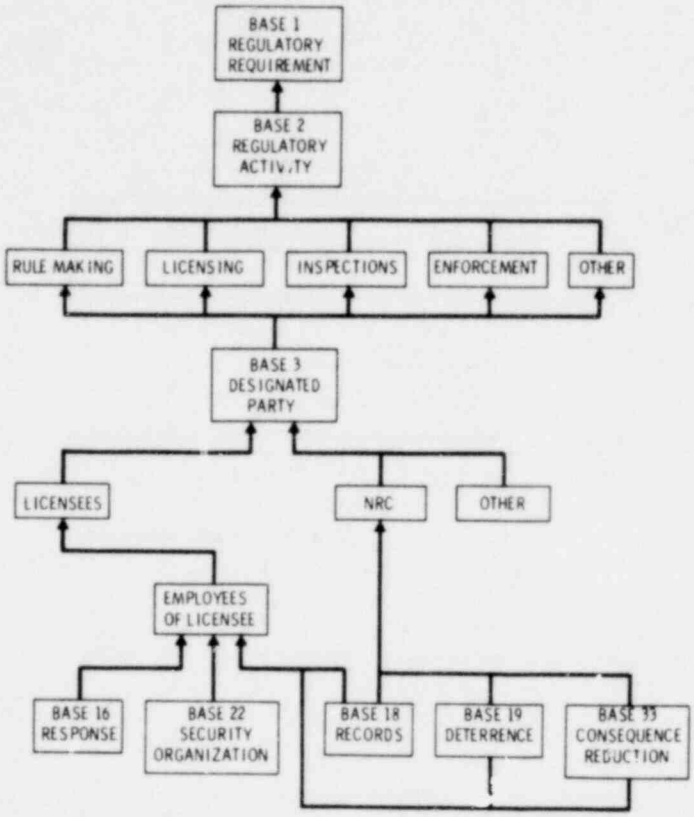

FIGURE 6.5. Responsiveness to Policy

Threat. A risk viewpoint in interpreting the regulations is reflected primarily in the proposed upgrade rules for Part 73 dealing with physical protection. In the proposed requirements, a major separation is made for protection of transit and protection at fixed sites. Here the structure and related bases are viewed independent of location. This perspective is depicted in Figure 6.6.

As shown, the major base associated with threats is Base 31 - Adversary Action. The functions of surveillance, investigation, response, deterrence and consequence reduction, safeguards intents and the adversary characteristics all support this perspective. At the top of the hierarchy of Figure 6.6, the act with which the requirement deals must first be determined. Intent is focused by adversarial acts and supported by the various functions. The specific functions, as shown, primarily deal with overt adversarial acts. Covert

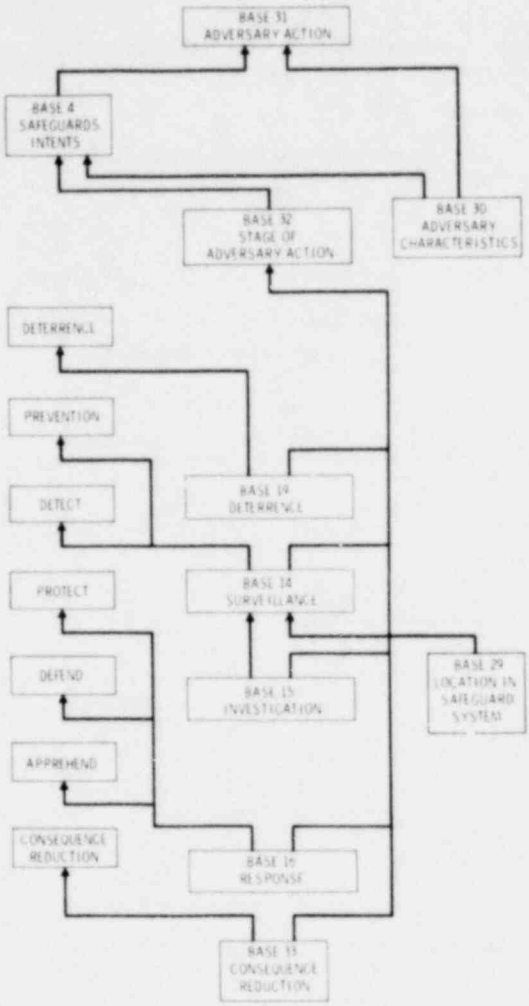

FIGURE 6.6. Threat Perspective

acts would include other functions such as access control. The intents of Base 4 are shown as served by the five functions identified for this structural representation. The functions, to a degree, are dependent on the stage of the adversary action. For example, deterrence is viewed as an a priori measure, conducted before an act is initiated.

Activity Direction. This perspective separates the regulations (and the bases) into those dealing with people or with objects such as physical devices. For this perspective, several of the bases shown in Figure 6.2 deal with both people and things. The bases which cannot be separated are:

Base 1 - Regulatory Requirement
Base 4 - Safeguards Intents
Base 15 - Investigation
Base 18 - Records and Reports
Base 33 - Consequence Reduction.

Recall that all of the bases were separated for this perspective, with the exception of Bases 8 and 32, each dealing with a sequence of activities.

Safeguards Functions. This perspective is a functional orientation to the structure of the safeguards regulations. For this perspective, a number of the elements of each base are shown in structural relationships. In Chapter 4, twelve of the bases are characterized as safeguards system functions.

In one sense the functions may be viewed as equal, none having particular precedence over another. In another sense, different functions can be shown as supportive of different activities or objectives. For example, Figure 6.6 showed five of the functions as supportive of safeguards intents that deal with adversary activities. Similar groupings of selected functions were presented in Figures 6.3-6.5.

The traditional separation of safeguards strategy, e.g. material control and accounting or physical protection discussed below, provides yet another organization for the various functions. The physical protection functions can be further separated in their elements by those at fixed sites and those dealing with transit activities. The following discusses other possible structures within the functions.

The temporal aspect of the safeguards functions in dealing with possible adversary acts was implied in Figure 6.6. Therein, the functions of deterrence, surveillance, investigation, etc. were presented in an order related to the various intents. This aspect is elaborated in Figures 6.7-6.9.

In Figure 6.7, the functions of surveillance and access control serve to detect abnormal situations or deviations from authorized activity. These two situations are listed as elements of Base 15 - Investigation, as they require investigation. Deviations from authorized and abnormal situations are shown at the top of the hierarchy in Figure 6.8. The former are related to procedures

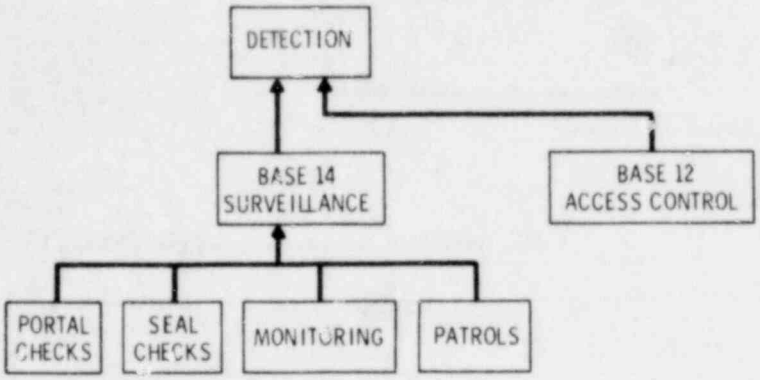

FIGURE 6.7. Detection

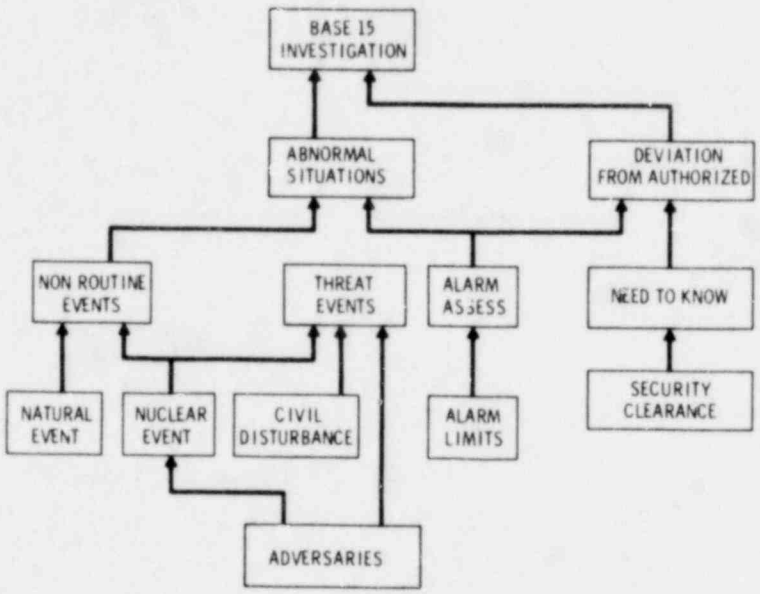

FIGURE 6.8. Investigation

and possible acts by people -- the elements need to know, and security clearances establishing that need, are shown as supporting this element. Abnormal situations are investigated to determine if they are non-routine (not adversarial) resulting from acts of nature or nuclear accidents.

Once a situation is investigated, it may merit a possible response. Responses are separated into those for contingencies or for threats in Figure 6.9. Events are identified as part of the investigation function. Events

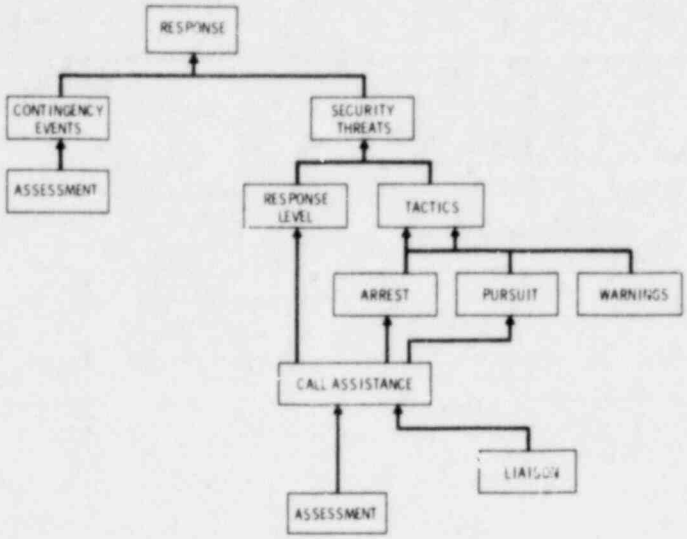

FIGURE 6.9. Response

are assessed to determine a response as part of the response function. If a threat event is the cause, assistance is first arranged, then responses are initiated. They may include arrest, pursuit, or warnings.

The function of access control, depicted in Figure 6.7, for detecting occurrences, can be structurally depicted in more detail as in Figure 6.10. There are three kinds of access control; vehicles, packages, and personnel. For vehicles, access may be to the inside of the vehicle (for transit protection) or to the inside of a facility via a vehicle. Access to facilities is controlled by monitors, isolation and search, registration, and locking devices. The various other elements of Base 13 are shown in relation to the methods of access control.

To this point, the structural aspects of several of the function-related bases have been investigated. Several of the other functions do not have inherent structures. For example, Base 19 - Deterrence is predominantly oriented to potential adversaries or saboteurs. Base 20 - Assurance, is related to safeguards intents (Base 4) and performance criteria (Base 12). Base 21 - Communications, is directed at procedures for personnel using equipment designed in Base 25 - Alarm and Communication Devices. Similarly, Base 23 - Accounting,

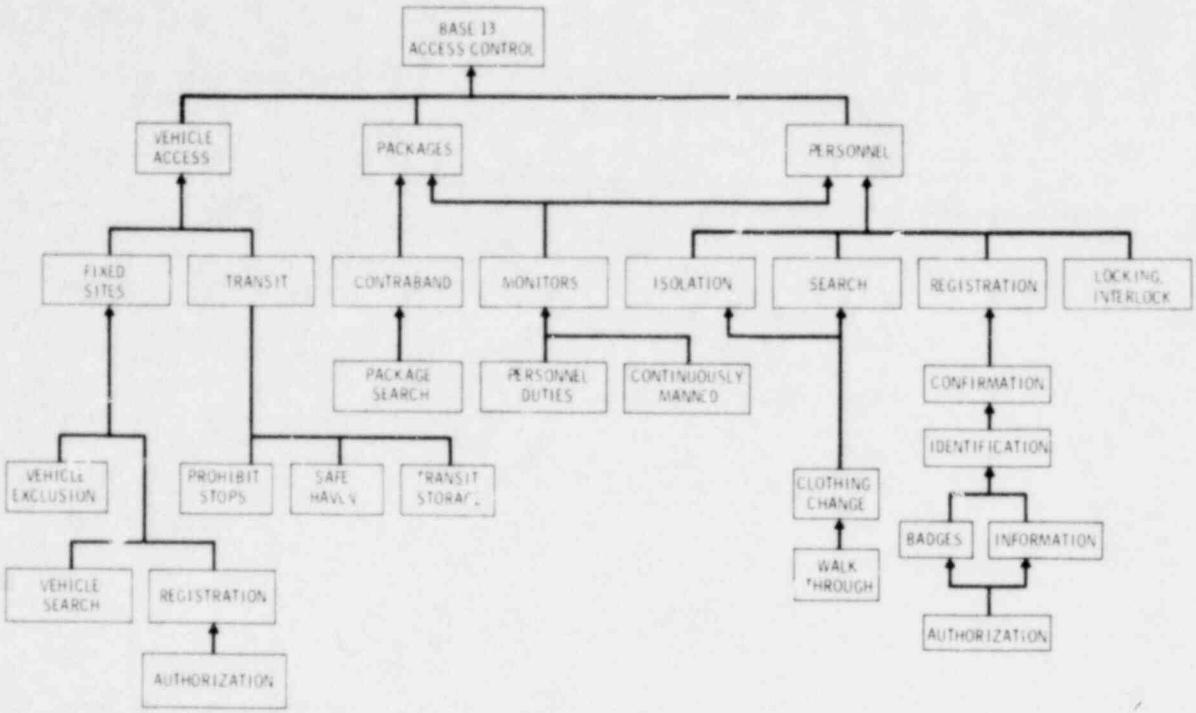

FIGURE 6.10. Access Control

is principally linked with Bases 9-11 characterizing nuclear material and Base 33 - Consequence Reduction is primarily related to the risk perspective.

Base 18 - Records and Reports, is used as an example in Figure 6.11 to show the general links of the elements of a functional base with other bases. In the figure, the various records and report elements are linked to each of the bases for which activities are documented. Notice in the figure that quality assurance is assumed to be a factor in all records or reports. Similar diagrams could be shown for each of the above mentioned bases not depicted here.

The final function to be considered is that described in Base 22 - Security Organization. This base lists the various attributes of the organization which provides physical protection. Figure 6.12 gives an example structure for the elements of this base. The separation made in the figure illustrates the relationship between management, personnel and procedure.

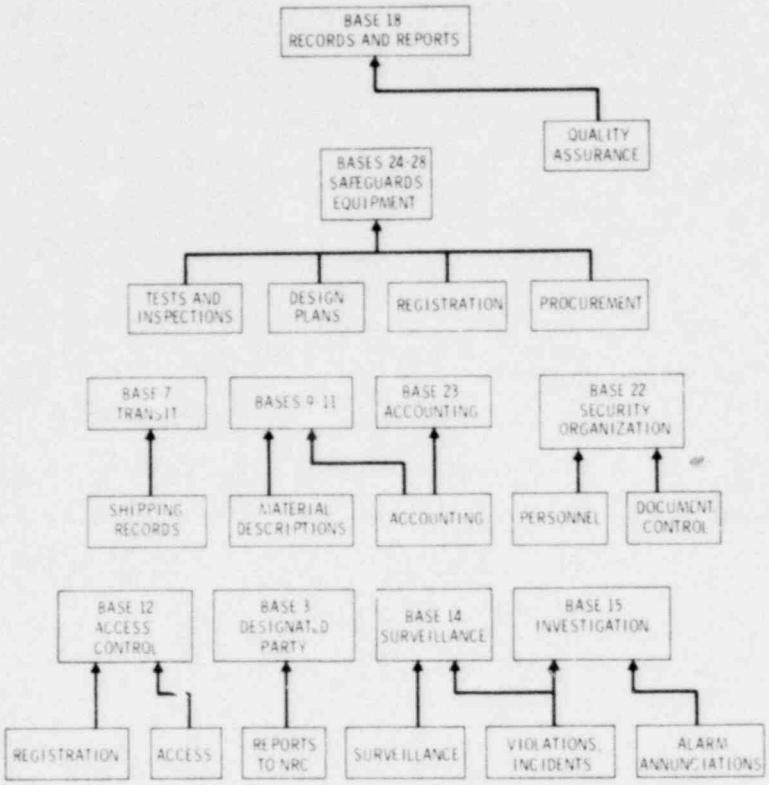

FIGURE 6.11. Records and Reports

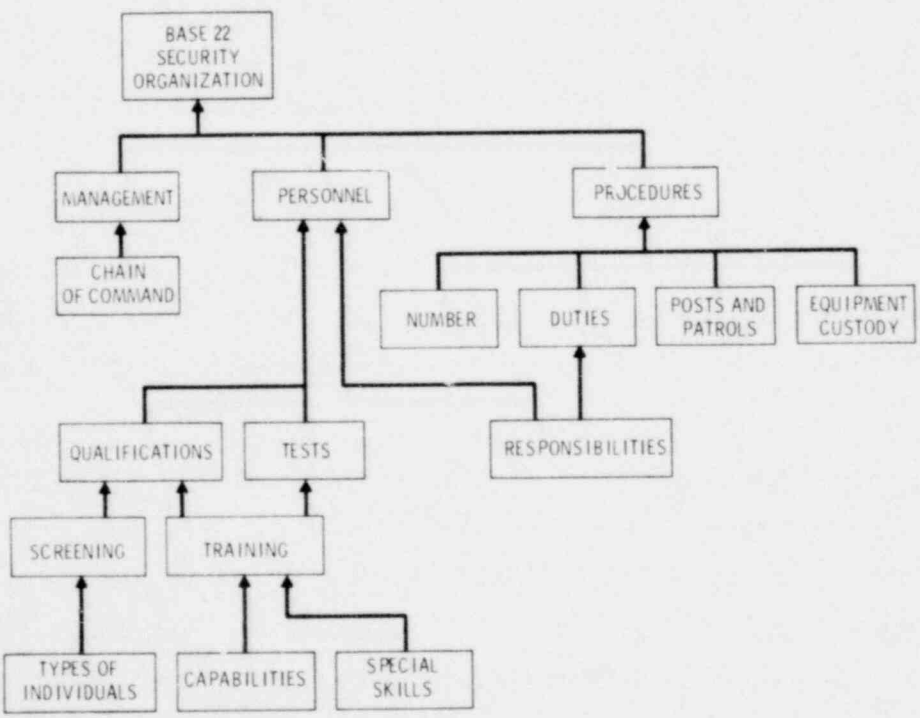

FIGURE 6.12. Security Organization

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Strategy. The perspective that separates requirements as material control and accounting or physical protection is most commonly used in structural representations of the safeguards requirements. Organizing the bases along these two divisions is not a simple matter. Each of the bases, as used for classification, has elements that may be characterized as material control and accounting or physical protection.

In Figure 6.2, the bases that deal primarily with material control and accounting or physical protection are distinguished. The difficulty in using this perspective stems from the meaning of the term "material control." Material control encompasses management and process controls which among other activities include vigilance over the material. To some extent the physical protection activities of surveillance and access controls may overlap the scope of material control. As shown in the figure, there is much overlap in the bases. It is, however, easy to classify the regulations as dealing with one or the other of the strategies.

Location. It is possible to organize the regulations by location. First, the physical protection regulations are separated as dealing with fixed sites and with transit. For fixed sites, the proximity of a given location to the nuclear material can be used to further subdivide and structure the various requirements. Figure 6.13 depicts the bases used to classify the locational aspects of the regulations.

Facilities and Materials. In Table 4.3 the various material quantities spelled out in the regulations were listed by quantity. Tables 5.5 through 5.7 related the general quantities to set of facilities spelled out in the regulations. The various bases used for making these determinations can be related as shown in Figure 6.14.

Systems Elements. The regulations dealing with procedures and specifications can sometimes specify types of devices or equipment necessary to carry out the requirements. The classification of the regulations' contents with this perspective was discussed in Section 4.7. This perspective interacts with the location perspective discussed above.

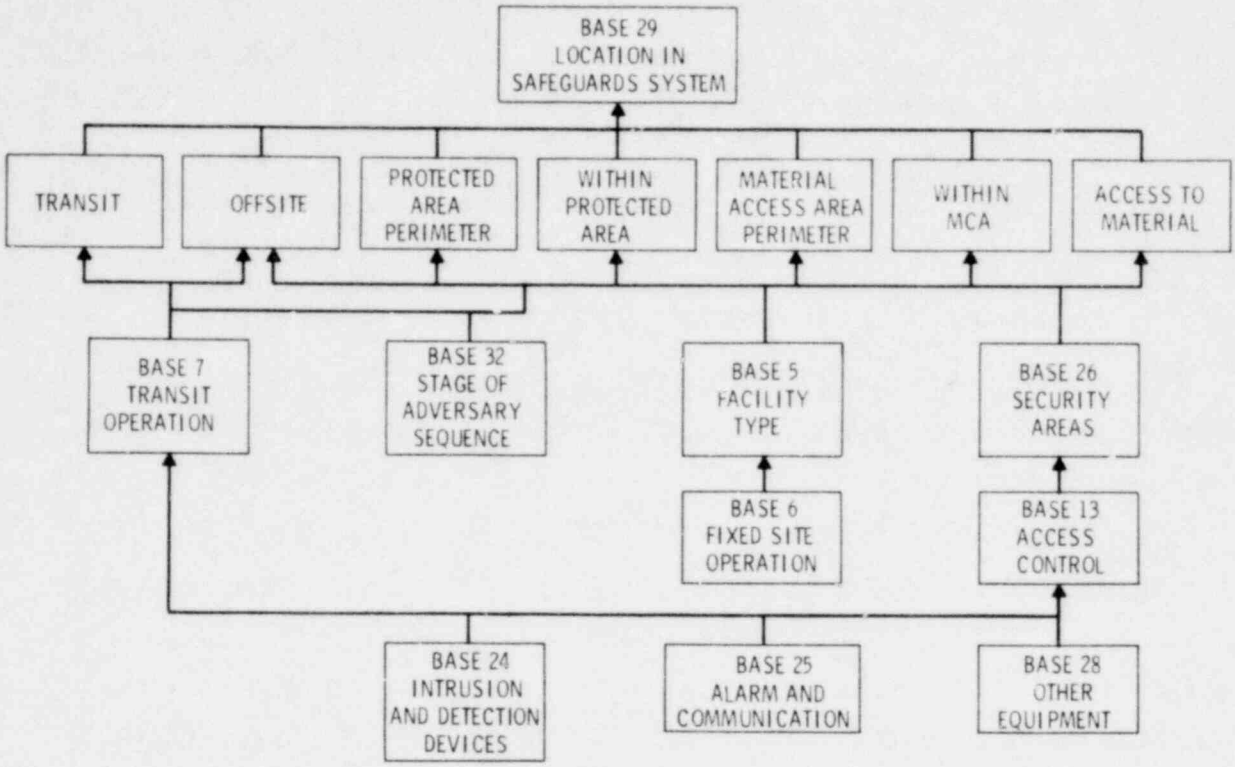

FIGURE 6.13. Location Perspective

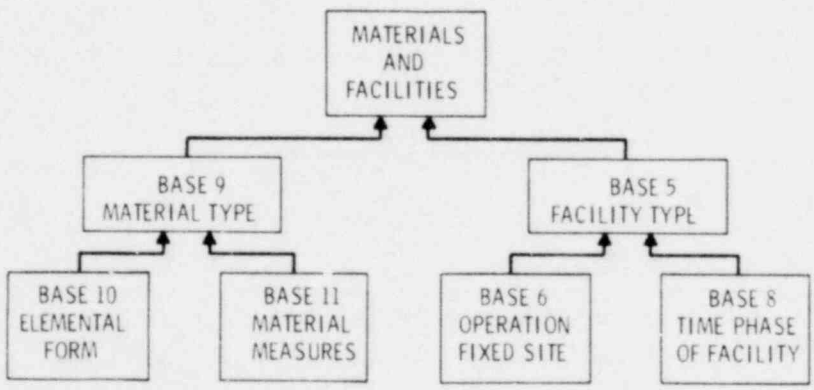

FIGURE 6.14. Materials and Facilities

6.3 A STRUCTURE FOR THE REGULATIONS

The assessment and the experience of developing the classifying methodology has provided insight about the regulations' structure. Many of the attributes which should be included in a comprehensive structure for the requirements are incorporated in the bases used for classifying the regulations' contents. This section summarizes those structural attributes.

Before considering the structure of the regulations it is important to consider the purpose of a structure.

First, the principal conclusion of this study is that the difficulties in interpreting the regulations rest with their organization and clarity. A structure is an arrangement for the parts that make up the regulations. As such, a structure for the regulations provides a guide which spans their purview.

Second, the regulations were found to be generally complete, consistent, and not contradictory. This can be gleaned from the current organization of the regulations. The structural approach used is a tool to systematically assess the requirements' contents. The current structure of the regulations is an adequate foundation for their presentation.

Finally, the systematic classification of the regulations also provides a basis for determining if regulatory changes are compatible and supportive of existing requirements. The structural approach allows ready identification of those requirements that interact with proposed changes.

In the second chapter of this report, the objectives and methodology for organizing the safeguards regulations were outlined. Chapter 3 used the concepts to develop a detailed set of categories to classify the regulations' contents. The application of the approach indicated that certain of the classifying categories are more useful than others for depicting the regulations' structure. The following discussion describes a structure for the regulations based upon the observations made in using the classifying methodology.

At the highest level of any structure are the goals or objectives of the system. For the safeguards regulations, these are the NRC's safeguards objectives. These objectives need not be explicitly stated as part of the requirements but the regulations must effectively communicate policy. This communication is achieved by characterizing the requirements' scope, activities, and functions.

The safeguards regulations can best be organized into three general groupings--those dealing with:

- Material control and accounting
- Physical protection
- License applications and conditions.

The scope of the requirements in Parts 70 and 73 can be broadly defined to encompass the licensing of activities involving nuclear material. Part 70 first spells out general licensing requirements, applications, and conditions of a license. The material control and accounting requirements of Part 70 and physical protection requirements of Part 73 detail the conditions of the license. This organizational structure is an integral part of the regulations as they are currently organized. The assessment indicated that this is a logical separation.

In the development of the classifying methodology the form and quantity of material were defined as objects to which the specific requirements are directed. For purposes of organizing the regulations the type of material and quantity levels also serve to specify the scope of each requirement. For each requirement or set dealing with similar functions the material quantities should be spelled out. The regulations already do this to the extent discussed elsewhere in this report.

The scope of the regulations are further bounded by specifying the following:

- Type of adversary acts which may include covert or overt theft of material, sabotage, or hoaxes.

- Performance required to meet its objective.
- Safeguards intent, which expresses the kind of action considered including prevention, deterrence, detection, control, protection, consequence reduction, etc.

The adversary act and intent may be combined by such phrases as "prevent sabotage" or "deter covert thefts." These general expressions serve to qualify the objectives of the requirements as a whole and need not be stated for each specific rule. Each rule, however, would be improved by specifying a performance measure which may be used to test compliance. Similarly, the responsible party who is liable for compliance and who must conduct the specified activity should be identified.

Thus far, the general characteristics of the regulations that delimit their scope have been discussed. Figure 6.16 depicts the various factors as a structure. As shown the safeguards regulations deal with the licensing of

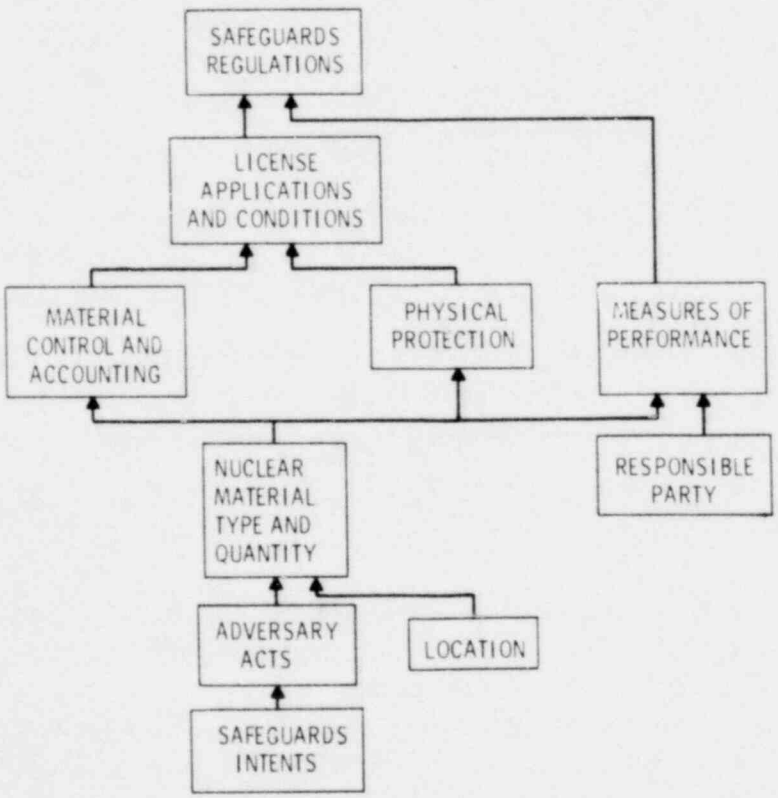

FIGURE 6.15. The Scope of the Regulations

holders of nuclear material. License conditions are separated for material control and accounting or physical protection. In either case the requirements are qualified by the types of material, its location, possible adversary acts, and the intent of the regulations in dealing with these acts. The importance of performance measures is stressed in the figure by depicting this aspect in parallel with the major safeguards strategies.

In the hierarchical representation of structure used in Chapters 2 and 3 to determine the classifying methodology, five concepts were defined. They are objectives, scope, activities, functions and objects. The objectives and scope are primarily depicted in the above discussion. The regulations, however, are best organized further along the lines of activities, functions, and objects. Material control and accounting and physical protection are the two principal activities.

Material control and accounting can be separated into two respective activities. These are spelled out in NUREG-0450 Report of the Material Control and Material Accounting Task Force. Material Control is accomplished by the process and management controls that assign and exercise responsibility over material, maintain vigilance, govern internal movement, and monitor its status. Material accounting is the procedures and systems to perform measurements, maintain records, provide reports, and perform data analysis.

This separation may be applied to the structure of the regulations. The current structure of the regulations, e.g., Sections 70.51 through 70.59, however, does not separate the two activities.

Physical protection activities, on the other hand, are separated into those at fixed sites and for transit. Figures 5.1 and 5.2 gave the structure of the transit and fixed site protection requirements respectively. This separation is a logical structure and simplifies the interpretation of regulatory requirements.

The various functions that focus the safeguards regulations as specific actions are sometimes confused with intents. For example, the use of terms such as prevention or deterrence are not functions per se. Functions such as access controls or surveillance serve the various intents, for example, by providing deterrence.

The classifying categories that describe safeguards functions were grouped together in Section 4.6 of Chapter 4. There, twelve functions were described. In general, each regulation overlaps in terms of the functions it specifies. Similarly, it is difficult to separate functions from intents. For example, Base 19 - Deterrence and Base 20 - Assurance are obvious intents of the safeguards regulations. Ir effect the regulations as a whole provide assurance and act as deterrents. These bases were defined to identify, in the regulations, specific areas that allude to these concepts.

The safeguards functions as defined for this study are reasonably independent of the activities of material control and accounting or physical protection. Physical protection includes the functions of access control, surveillance, and response. The accounting function obviously deals with material control and accounting. Figure 6.16 depicts the relationship of the various safeguards functions as used by this study.

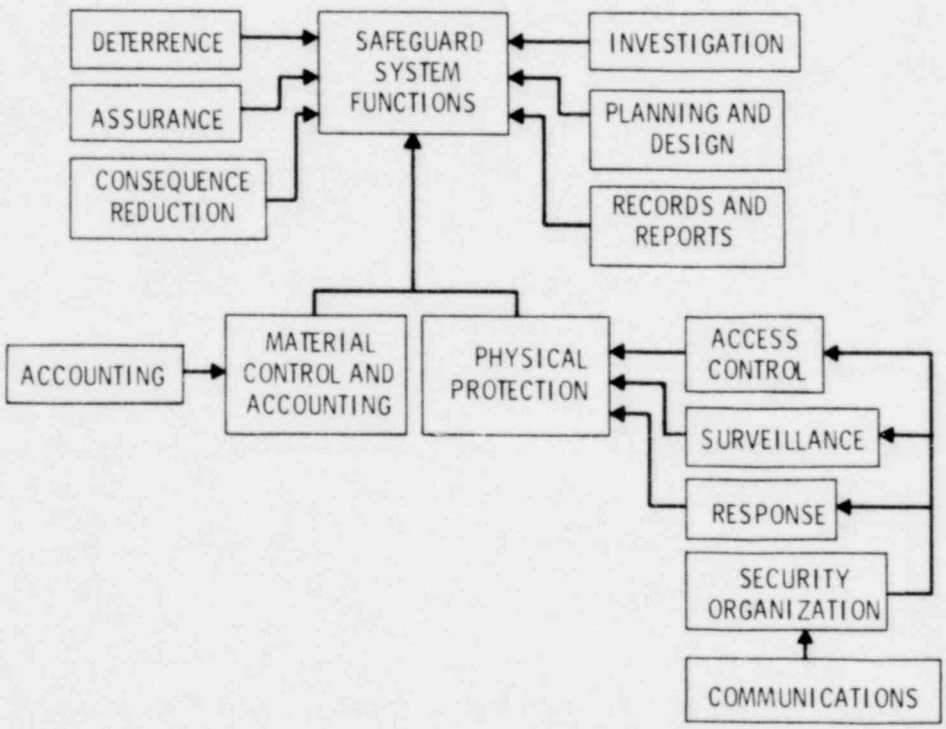

FIGURE 6.16. Safeguards Functions

The objects of the requirements can be separated into those that are necessary for the function of the safeguards system and those which further qualify the purpose of the functions:

- Objects which serve a function are: security areas, intrusion and detection devices, alarm and communication systems, and protective equipment.
- Functions may be further qualified by specifying or exempting material types and quantities, location and so forth.

The various bases that are objects of the safeguards functions were discussed in detail in the report. The safeguards regulations generally specify objects within each separate section or paragraph. Functions are further qualified by the exemptions spelled out in the regulations.

The various functions and objects treated by the safeguards regulations can be readily identified by a careful review of each section's contents. Given a specific viewpoint the structuring methodology allows rapid identification of all sections that deal with that viewpoint.

In the safeguards regulations, the licensing process is the principal means by which the NRC's objectives are implemented. Requirements are primarily separated by the strategy of the safeguards activity and by the major objects toward which functions are directed. The strategies are material control and accounting or physical protection; objects are material types and quantities and location, e.g., fixed site or transit.

There is no one way to characterize a general structure for the safeguards regulations. Each reader's purpose in reviewing the regulations will be different. The regulations cannot reflect each purpose or viewpoint in their organization. It is important, however, that each requirement or set of requirements be clear in specifying NRC policy, the scope of the requirement, and the performance necessary for compliance.

This study has assessed the structure and contents of the safeguards regulations in a systematic manner. In effect a number of structures have been presented. These structures account for the various activities addressed by the requirements and their viewpoints taken in their interpretation.

7.0 INTERACTION OF SAFEGUARDS REGULATIONS WITH LICENSING AND TRANSPORTATION REGULATIONS

The requirements of Part 50 (Licensing of Production and Utilization Facilities) and Part 71 (Packaging of Radioactive Material for Transport and Transportation of Radioactive Material under Certain Conditions) are considered in this chapter. Of the various NRC requirements, with the exception of safety requirements considered in the next chapter, these two parts of Chapter 10 CFR have the greatest interaction with the safeguards regulations (Parts 70 and 73).

The safeguards requirements for nuclear power reactors (Section 73.55) definitely interact with the licensing requirements of Part 50. *Because the requirements of Part 50 focus on the licensing of facilities whereas the safeguards regulation deal with licensing of material and its protection, interactions were found to be neutral. The packaging and transportation requirements of Part 71 were similarly found not to conflict with the safeguards regulations.*

As was shown in Chapter 5, the safeguards regulations interact among themselves primarily due to overlapping areas of concern. Given a systematic taxonomy that identified general areas of concern, it was relatively easy to identify the set of regulations dealing with the same concern. The organizational structure and methodology for classification simplified the process of determining interactions. The development of a similar classifying method which includes the aspects of Parts 50 and 71 is beyond the scope of this study. As a result, the potential for interaction between the safeguards regulations and these two Parts is approached at a basic level.

7.1 INTERACTION OF PART 50 AND PARTS 70 AND 73

The requirements of Part 50 deal with the licensing of production or utilization facilities whereas Parts 70 and 73 deal with material, e.g., special nuclear material. The principal safeguards sections that interact with Part 50 are the licensing requirements of Part 70, Sections 70.18 to 70.39 and the nuclear power reactor physical protection requirements of Part 73, Section 73.55.

In Part 70, the requirements of Part 50 are referenced primarily by exceptions. Sections 70.22(h), 70.24(c), 70.51(e), and 70.57(b) exempt the operation of a nuclear reactor licensed pursuant to Part 50 from their specific requirements. Conversely, Section 50.2(a)(3)(iii) defines "production facilities" to include facilities licensed pursuant to Part 70; otherwise, no other references are made from Part 50 to Part 70.

In Part 73, the requirements of Part 50 are referenced in the following sections: Section 73.1(b), "This part prescribes requirements for (i) the physical protection of production and utilization facilities licensed pursuant to Part 50"; Section 73.2(a), common terms and definitions; Section 73.50, licensees of Part 50 must comply with physical protection requirements for licensed activities; and Section 73.55, nuclear power reactor physical protection requirements. Part 50 references Part 73 in Section 50.34(c).

The licensing requirements of Parts 50 and 70 refer to the licensing of "facilities" and to special nuclear material, respectively. The term "facility" is used to include both a "production facility" and a "utilization facility". A production facility is any equipment or device capable of producing quantities of SNM of significance to the common defense and security, or in such manner as to affect the health and safety of the public. A utilization facility is any equipment or device, except an atomic weapon, which uses SNM in quantities significant to the common defense and security or in such manner as to affect the health and safety of the public.

The requirements of Part 50 better qualify the definitions of facility. In Section 50.2(a)(2)(3) of 10 CFR a production facility is (a) one designed or used for the separation of isotopes of uranium or plutonium, or (b) one designed or used for the processing of irradiated materials. A reactor designed for the formation of plutonium or ^{233}U is a production facility. Any nuclear reactor other than one so designed or used is a utilization facility (Section 50.2(b)).

The basis for interaction of the requirements of Part 50 and Part 70 is that special nuclear material is the basic fuel for nuclear reactors and also the basic substance used for nuclear weapons. In Part 70, the NRC specifies

requirements for either general or specific licenses for activities involving SNM; activities involving SNM require a specific license.

The principal activities that also come under the licensing requirements of Part 50 are nuclear power plants as utilization facilities. In this Part, the construction and operation of a nuclear reactor are directly subject to licensing. Although both material licenses and facility licenses are required, the two types of requirements are combined into a single licensing proceeding. Production facilities for the enrichment of uranium are currently owned by the U.S. government. These types of facilities, including reprocessing plants, if privately owned, are also subject to the requirements of Parts 50 and 70.

To determine the interaction of Part 70 and Part 50, the licensing requirements of each were compared. Section 5.2 of Chapter 5 detailed the license application requirements and conditions spelled out in Part 70. The licensing requirements are arranged somewhat differently in Part 50; there the licensing of construction and operation is treated as a sequence of activities.

In Section 50.35(a), the issuance of construction permits is based on the assumption that applications may not contain all the required technical information relating to the details of the proposed facility. Nevertheless, a construction permit can be issued if the Commission finds that the information provided contains the:

- proposed design and major features to protect the health and safety of the public
- assurance that omitted technical information will be supplied in the final safety analysis
- descriptions of safety features requiring research and development and assurance that they will be developed
- reasonable assurance that the facility will be safely operated.

Section 50.35(b) indicates that a construction permit does not constitute NRC approval of safety of any feature unless included specifically in the permit.

Upon completion of construction, Section 50.57 spells out the requirements for the issuance of an operating license. Those requirements include that:

- construction in accordance with the construction permit and the regulations has been completed
- operation will conform with the application and with the regulations
- the public's health and safety are assured and all requirements are met
- the licensee is technically and financially qualified
- operation will not jeopardize national defense or security.

Once an operating license is approved, the licensee is subject to a number of continuing requirements. For example:

- Section 50.36 - amendments to the license for technical changes
- Section 50.59(c) - changes in facility that involve any unreviewed safety questions
- Section 50.59(b) - records of changes to facility or operating procedures
- Section 50.70 - inspections
- Section 50.71 - reports.

Licenses are not alienable (Section 50.81) and are subject to suspension or revocation on account of any material false statement, failure to operate in accord with the license, or violation (Section 50.100). Material may be retaken or the facility may be taken over and operated for various reasons such as a war or national emergency or in the public interest (Sections 50.101, 50.103 and 50.102 respectively).

Because the material licensing requirements of Part 70 are often conducted in parallel with the facility licensing requirements of Part 50, it is useful to compare the requirements. Table 7.1 presents the content requirements of license applications as contained in Part 50. These can be compared with the requirements of Part 70 shown in Table 5.1 in Chapter 5.

A similar presentation as shown for Part 70 in Table 5.3 is made for the conditions of licenses in Table 7.2.

Although there is some duplicity in the general information requirements for license applicants, the detailed information required for facility and material licenses is different. As can be seen in comparing Table 7.1 and 5.1, the requirements of Part 50 are primarily technical. These technical requirements are further summarized in Table 7.2.

TABLE 7.1. Content of License Application
(Production and Utilization Facilities)

	Reference Code
1. Purpose and Requirements: To provide for the licensing of production and utilization facilities	50.1 50.10
2. Types of Licenses: Two classes	50.20
Class 104: for medical therapy and research and development facilities,	50.21
Class 103: for commercial and industrial facilities	50.22
Construction permits: construction, alteration	50.23 50.56 50.91
Export licenses: export of production facilities	50.65
3. Information	50.33
General: 1) Name, address, description of business, citizenship; for partnership same information for partner; for corporation, state of incorporation, principal location, officers, control. 2) class of license applied for. 3) financial qualification. 4) dates for alteration or construction completion. 5) Restricted data or defense information. 6) for Class 103 other regulatory agencies.	
Antitrust information	50.33(a)
4. Description of technical information	
Preliminary safety analysis	50.34(a) 50.46
Final safety analysis	50.34(b) 50.36
Physical security plan	50.34(c)
Design of release control equipment	50.34(a)

TABLE 7.2. Condition of License Application
(Production and Utilization Facilities)

	Reference Code
1. License Requirements	50.1
a. No person shall transfer or receive in interstate commerce, manufacture, produce, transfer, acquire, possess, use, import or export and production or utilization facility except as authorized by a license.	50.10

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	Reference Code
b. License will not be inimical to common defense or security.	50.40(c)
c. Applicant will comply with the requirements of this chapter (10 CFR), and be conducted without endangering public health and safety	50.40(a) 50.57(a)(3)(d) 50.109(b)
2. Issuance	50.50
a. Construction permit	50.35
b. Operating license	50.57
c. Ineligibility of certain applicants	50.38
3. Duration, Expiration, Renewal, Revocation	50.51
a. Revocation, suspension or modification	50.54(d)(e)(f) 50.100,50.103
b. Amendments	50.90 50.91
c. Retaking of SNM	50.101
d. Operation after revocation	50.102
e. Termination	50.82
f. Expiration of construction permit	50.55(b)
4. Limitations	
a. Rights as defined, no transfer of rights without application.	50.80 50.54(c)
b. All SNM subject to recapture or control.	50.101 50.54(d)
c. Only written interpretation by Commission	50.3
d. No waiver from anti-trust laws.	50.54(g) 50.55(b)
e. Commission may incorporate in any license any additional conditions it deems appropriate.	50.54(n)
f. No changes in security plans.	50.54(p)
g. No changes in technical specifications.	50.54(n)
h. No unlicensed operations.	50.54(i)(j)(k)(l)
i. Construction permit subject to same conditions as license.	50.55(c)
j. No material rights except as specified.	50.54(b)
k. Limited access to restricted data.	50.37 50.33(j)
5. Conditions, Codes and Standards	
a. Qualifications of applicant.	50.22(a) 50.33(f) 50.34(a)(6)(9) 50.34(b)(6)(i) 50.40(b) 50.57(a)(4)

	Reference Code
b. Activities conducted with minimum environmental impact	50.10(d)(2)(3) 50.12(b)(2) 50.34(a)(6)(2) 50.36(a)
c. Safety analysis and requirements	50.10(e)(2) 50.30(c) 50.34 50.35(a) 50.36(c)(1) 50.40(a) 50.55(e)(1)(iii) 50.55(a) 50.59(a) Appendix I
d. Security plans	50.34(c) 50.13 50.58
e. Technical requirements, design, evaluation	50.34(a)(3)(4) 50.34(b)(2)(4) 50.34(a) 50.35(a) 50.36 50.36(a) 50.40 50.46 50.54(n)(o) 50.55(e) 50.55(a) Appendices A,G,H,J-O
f. Quality assurance	50.34(a)(7) 50.55(e) Appendix B
g. Research and Development	50.34(a)(8)
h. Emergency Plans	50.34(a)(10) 50.34(b)(6)(v) Appendix E
i. Inspections	50.55(a)(g) 50.70
j. Records	50.59(b) 50.71

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The general security plan requirements of Part 70 and Part 73 can be viewed as an elaboration of the requirements of Part 50.

Because the material licensing process of Part 70 is conducted in conjunction with the facility licensing of Part 50 for applicants requiring both types of license:

- *The safeguards requirements and the facility licensing requirements were not found to be in conflict.*

Because Part 50 refers to Part 73 for physical protection requirements at licensed facilities, there were similarly no contradictions between these two parts.

7.2 INTERACTION OF PART 71 AND PARTS 70 AND 73

Almost all the requirements in Part 71 deal implicitly with preparation of fissile material for transit. These requirements apply primarily to shipments not intended for export. Section 71.5 presents the scope of this Part. The licensee who is authorized to ship nuclear material pursuant to this Part must also comply with the applicable Department of Transportation requireme in 49 CFR. The requirements of Part 71 can be interpreted as both parallel the DOT requirements and supplementing them.

The requirements of Part 71 were analyzed in detail in this study. At first reading, however, it is difficult to determine the interactions of the transportation requirements of this Part with the safeguards requirements of Parts 70 and 73. This section describes the requirements of Part 71 and concludes with a consideration of the requirements of Parts 70 and 73 with this Part.

Part 71 is primarily concerned with the determination of shipping requirements and the preparation and packaging of those shipments for transportation. Based upon the radioactive materials and their quantities, the shippers and receivers of licensed material must also meet the licensing requirements spelled out in Part 71. Note that the responsibility for transportation of SNM rests with the shipper or receiver and not with the carrier, who is not required to be a licensee.

The fact that the requirements of this Part both parallel and interact with DOT regulations, although important, is not considered in detail. Part 71 covers the case of shipment or packaging of large amounts of nuclear material requiring special procedures or equipment beyond those specified in the DOT regulations.

In order to work one's way through the regulations in Part 71 a set of basic data describing the material to be shipped must be known. The basic data are as follows:

1. principal radioactive element(s) in the shipment, listed by isotope
2. activity level of each isotope, in curies
3. the physical form of the material, i.e., solid, liquid, or gaseous
4. the specific activity of the materials in the shipment, where the solids are given in microcuries per gram, and the liquids are given in microcuries per millimeter.

The licensee must also be aware of the general DOT rules that govern the packaging standards to be met in the shipment of any hazardous materials. The standards spell out the shipper's responsibility, rules regarding previously authorized packaging, standard requirements for all packages, and reuse of containers. They are not unique to the shipments of radioactive materials and are contained in Sections 173.22, 173.23, 173.24 and 173.28 of Chapter 49 CFR.

To be concerned with the requirements of Part 71, the licensee will be more than likely dealing with special nuclear material (referred to as fissile material in this Part) or with larger shipments of other material not defined as SNM. This specification is given in Section 71.1 paragraph (a). The first step in determining shipping and packaging requirements is simply to determine if the material is radioactive. Section 173.389 paragraph (e) of 49 CFR gives the necessary definition.

Figure 7.1 depicts the sequence of determinations and decision points required by Part 71 of 10 CFR. As with the other kind of interactions among the various regulations, it is difficult to determine a sequence or set of interactions at first reading. Given such a diagram as a guide, a number of possible confusions can be eliminated. In the figure, the rectangles indicate

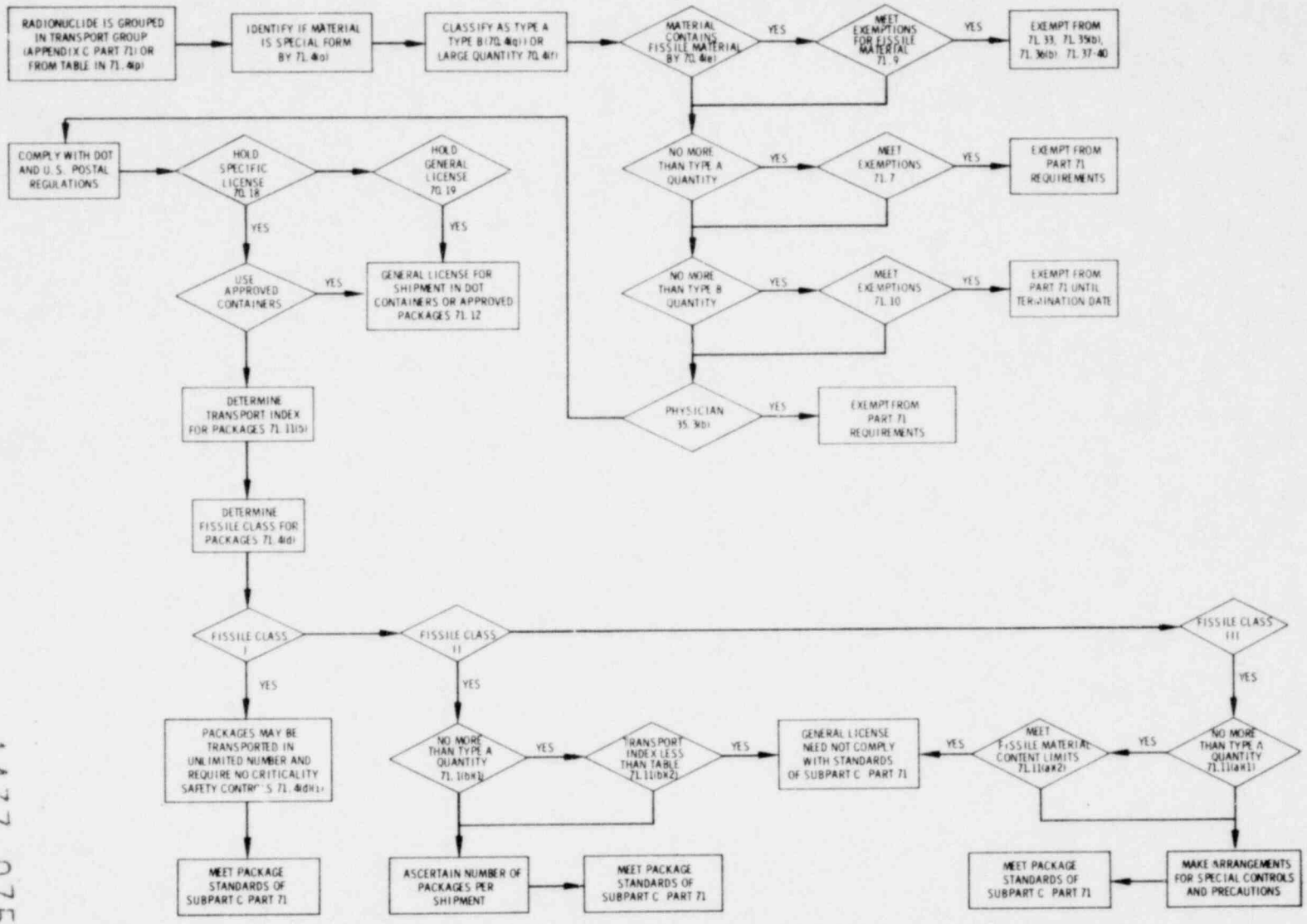

FIGURE 7.1. Determining Packaging Requirements from Part 71

determinations regarding the material or necessary points of compliance. Depending on these determinations, the regulations alsc indicate decision points which establish additional determinations or mark points of departure from the requirements of Part 71. The following discussion of this section follows the possible paths depicted in Figure 7.1.

Determine Transport Group. The first necessary determination in following the requirements in Part 71 is to establish the transport group. As shown in Figure 7.1, transport groups are defined in Section 71.4 paragraph (p) or by the table given as Appendix C of the same part. Section 173.390 of 49 CFR parallels the above definition.

Define Special Form. Is the material in special form as defined in Section 71.4 paragraph (o)? Special form materials are those which, if released from a package, might present some direct radiation hazard but would present little hazard due to radiotoxicity and little possibility of contamination. To qualify as special form material, the material must be in solid form or encapsulated. Appendix D of Part 71 lists four tests to verify the determination. This parallels Sections 173.389 paragraph (g) for the definition and 173.398 paragraph (a) for the tests in 49 CFR.

Determine Quantity Type. Does the shipment constitute a Type A, Type B, or large quantity shipment? The numbers listed in Section 70.4 paragraph (f) are upper limits for these categories.

Given the above three determinations, possible exemptions from Part 71 may be considered. Four major decisions are given in Figure 7.1. They cover the exemptions contained in Sections 71.6 through 71.10 of Part 71. With the exception of being exempt from the requirements of Part 71 in its entirety, the licensee should again depart to the applicable DOT regulations to assure general compliance.

The regulations in Part 71 basically apply to holders of specific licenses. However, Section 71.19 provides a decision point for holders of general licenses. Section 71.12 provides a general license for shipment in DOT approved containers. This again denotes a departure point back to the DOT regulations for general requirements. These are contained in Part 173, Section 173.393 of

49 CFR. Once the licensee has determined that the regulations of Part 71 still apply to his situation, he is then ready to select a package for his shipment. Two additional determinations are next necessary as indicated in Figure 7.1.

Determine Transport Index. Section 71.1 paragraph (b) gives maximum quantities for single packages. Therein, a corresponding transport index can be determined from the table for fissile material.

Determine Fissile Class. Section 71.4 paragraph (d) defines fissile classes according to the necessary packaging controls needed to provide criticality safety during transport. The definition here again parallels the DOT requirements in Section 173.389 paragraph (a) of 49 CFR.

The remainder of Figure 7.1 (and of Part 71) deals with the packaging specifications for each fissile class shipment. Of primary concern are Fissile Class III shipments. Under circumstances spelled out in Section 71.11 paragraph (a)(2) the holder of a specific license may need to make special arrangements for packaging and shipment.

The general observations regarding the determination of packaging and shipping requirements in Part 71 are:

- *The interactions in Part 71 are primarily with parallel DOT requirements which take precedence over the requirements of this part.*
- *It is possible to determine a sequence of determinations and decision points regarding shipping and packaging which clarify a path for shipping preparations not readily obvious from the organization of the requirements in this Part.*
- *There are no conflicts in the regulations of Part 71; they interact in a sequence rather than overlap. A cursory examination of overlaps with the DOT regulations in 49 CFR shows parallel requirements but no obvious negative interactions.*

For holders of specific licenses as given by Part 70, there are two important considerations in addressing the requirements of Part 71. They are:

1. determining the material quantity (SNM) and the specific requirements of Part 71 that hold for that quantity, and
2. identifying if the safeguards requirements conflict with the shipping and packaging requirements.

In Part 71, the principal material measure separating the packaging requirements is radioactivity. Table 7.3 lists the radioactivity measures used in Part 71 (with exceptions indicated). The table is separated into three parts: radioactivity in curies, Type A or B quantity, and dose rates. These measures are used for the purpose of safety and radiation protection rather than by the strategic value of the material.

The measurements used to specify material quantities are not used inconsistently in the safeguards regulations. The material control and accounting requirements were, in general, specified for smaller quantities than the physical protection requirements. The material specifications of Part 71, however, are difficult to compare with the safeguards requirements. The analysis did not find any inconsistencies in the material specifications of Part 71.

The requirements of Part 71 were also compared with the physical protection requirements of Part 73. The transit physical protection requirements were not found to be in conflict with shipping requirements. The principal difficulty in comparing the safeguards regulations with this part is:

- *The requirements of Parts 70 and 73 refer primarily to SNM. The regulations of Part 71 refer to fissile material. The distinction between SNM and fissile material is not great and in a sense indicates an inconsistency in terminology.*

This difficulty clouds the interpretation and comparison of the safeguards requirements with this part. The assessment did not find any interactions that represented conflicts or inconsistencies that would jeopardize compliance with either Part 70, 71 or 73.

TABLE 7.3. Radioactivity Requirements

Radioactivity	Material Type	Description	Reference
>50,000 curies	Group VI or VII radionuclides	Definition of large quantity	71.4(f)
<50,000 curies	Group VI or VII radionuclides	Type B definition	71.4(q)
>5,000 curies	Group V radionuclides	Definition of large quantity	71.4(f)
>5,000 curies	Special form material	Definition of large quantity	71.4(f)
<5,000 curies	Group V radionuclides, Special Form	Type B definition	71.4(q)
<1,000 curies	Group VI or VII radionuclides	Type A definition	71.4(q)
>200 curies	Group III or IV radionuclides	Definition of large quantity	71.4(f)
<200 curies	Group III or IV radionuclides	Type B definition	71.4(q)
>20 curies	Group I or II radionuclides	Definition of large quantity	71.4(f)
<20 curies	Group IV or V, Special form material	Type A definition	71.4(q)
<20 curies	Group I or II radionuclides	Type B definition	71.4(q)
>20 curies	Pu	Packaging and shipping instructions	71.42
20 curies	Pu or U-233	Scope of regulation	73.1
>20 curies	Pu or U-233	No shipment by air	73.32
<10 curies	Group III, IV radionuclides	Levels for package release and coolant contamination	71.36(a)
<3 curies	Group III radionuclides	Type A definition	71.4(q)
<1.000 curies	Inert gas	Levels for package release and coolant contamination	71.36(a)
<0.5 curies	Group II radionuclides	Levels for package release and coolant contamination	71.36(a)
<0.5 curies	Group II radionuclides	Type A definition	71.4(q)
<0.01 curies	Group I radionuclides	Levels for package release and cooland contamination	71.36(a)
<9.0001 millicuries	Group I radionuclides	Low specific activity definition	71.4(g)
<5 millicuries/ml	Tritium oxide	Low specific activity definition	71.4(g)
<0.001 millicuries	Group I radionuclides	Type A definition	71.4(q)
<0.3 millicuries	Groups III or IV radionuclides	Low specific activity definition	71.4(g)
$<3 \times 10^{-4}$ curies	Group III or IV radionuclides	Contamination level for coolant	71.35(a)
<5 microcuries	Pu source	Maximum amount for general license	70.19(c)(1), 70.39
<0.005 millicuries	Group II radionuclides	Low specific activity definition	71.4(g)
$<5 \times 10^{-6}$ curies	Group II radionuclides	Contamination level for coolant	71.35(a)

TABLE 7.3. Radioactivity Requirements (Cont'd)

Radioactivity	Material Type	Description	Reference
<0.001 millicurie	Group II-VII radionuclides	Low specific activity definition	71.4(g)
>0.01 microcuries	Pu source	Requirements for transfer of source	70.39(c)
<0.0001 millicurie	Group I radionuclides	Low specific activity definition	71.4(g)
$<1 \times 10^{-7}$ curies	Group I radionuclides	Contamination level for coolant	71.35(a)
<0.005 microcuries	Pu source	Requirements for specific license to manufacture sources	70.39
<0.002 microcurie/g	Licensed material	Exemption for no more than Type A quantity	71.7
	Type A and B Quantities		
Large quantity	Licensed material	Structural standards for packaging	71.32
<Type B quantity	Licensed material	Limited exemption	71.10
<Type B quantity	Licensed material	Conditions of general license	71.12
<Type B quantity	Licensed material	Structural standards for packaging	71.32
<Type A quantity	Licensed material	Exemption for no more than Type A quantity	71.7
<Type A quantity	Licensed material	Conditions of general license	71.11
<Type A quantity	Licensed material	Standards for normal conditions for transport	71.35(a)(c)
<Type A quantity	Licensed material	Standards for hypothetical accident condition	71.36(a)
<Type A quantity	Licensed material	Records specifications	71.62
Low specific activity materials	Licensed material	Limited exemptions	71.36(a)
	Dose Rates		
<20 rads/2 meters/minute	Neutron gamma radiation	Limits for monitoring system	70.24(a)
300 rems/1 foot/hour	Neutron gamma radiation	Limits for monitoring system	70.24(b)
>5 millirems/hour	Neutron gamma radiation	Alarm point for monitoring system	70.24(b)
>100 rems/hour @ 3 ft	SNM	Exemptions for land and quantities of SNM	73.6

8.0 THE INTERACTION OF SAFETY AND SAFEGUARDS REGULATIONS

Other regulations also affect the activities of NRC licensees. One particularly important set of regulations is public and worker safety regulations, as promulgated by the NRC itself and some 65 other federal agencies. How these requirements interact with the NRC's safeguards regulations is a possible concern: in particular, could the presence of safety regulations make compliance with safeguards regulations more difficult or even impossible?

- *The great majority of safety requirements of other Federal agencies do not interact with the NRC's safeguards regulations because they do not affect the same people and activities.*

- *Of those safety requirements that do interact with the safeguards regulations, most interact in a neutral way; complying with both the safety and safeguards requirements regulations is no more difficult than complying with each separately.*

It should be emphasized that these conclusions rest on analysis of the written regulations, rather than on how requirements are interpreted in practice by agencies and licensees. A detailed investigation on how the regulations are interpreted would further focus on their potential for conflict. It is anticipated that such a focus would reveal a reduced potential for conflict.

This chapter consists of four sections. Section 8.1 discusses the federal agencies concerned with public and worker safety, briefly describes the regulatory concern of each, and notes which regulations can be excluded from possible interaction with safeguards requirements on the basis of differing regulatory concern. Section 8.2 focuses on the regulations not excluded by the analysis in the first section. It groups, by agency, the requirements that appear potentially to interact with the safeguards regulations. Section 8.3 explains how the selected safety requirements could interact with safeguards requirements and isolates the nature of specific interactions. The final section summarizes the various observations regarding interactions.

8.1 THE AGENCIES

Since the passage of the Federal Food and Drug Act and the Meat Inspection Act in 1906, the federal government has become increasingly involved in protecting the worker, the consumer and the environment.(1) Through the 1960s, federal worker and public legislation largely followed a "hazard-by-hazard" or "product-by-product" approach.(2) As a result, the authority to promulgate safety regulations (and to support the regulation of safety through advice and information) was diffused through a very large number of federal departments and agencies. During the 1970s, some of this authority was consolidated in three new entities: for worker safety, the Occupational Health and Safety Administration (OSHA), located within the Department of Labor; for product safety, the Consumer Product Safety Commission (CPSC), an independent commission; and for environmental preservation, the Environmental Protection Agency (EPA), an executive agency located outside any executive department. However, creation of these agencies did not fully consolidate federal safety regulation into the three clusters. Numerous other federal agencies remain involved.

Table 8.1 sets out the principal federal agencies involved in public, worker, and environmental safety regulation. The first column of the table identifies the agency and the department in which it belongs (if any) is indicated in parentheses. The scope of the agency's regulatory concern in the realm of safety is given in the second column.

TABLE 8.1. Principal Agencies Involved with Safety Regulation

Agency	Regulatory Concern
Advisory Committee on Construction Safety and Health (Labor)	advise Labor Secretary on promulgation of construction safety and health standards
Aerospace Safety Advisory Panel	advise NASA administrator on safety of facilities and operations
Agriculture Department	inspect and certify agricultural products in interstate commerce
Air Force	monitor and detect radiation levels
Bureau of Standards (Commerce)	investigate radiation, radioactive substances, and the means of protecting persons from their harmful effects
Coast Guard (Transportation)	establish safety regulations for noncommercial boats and equipment
Consumer Product Safety Commission	establish consumer product safety regulations and provide information to consumers about product safety
Defense Department	manage defense-related radioactive materials
Environmental Protection Agency	establish effluent and/or ambient standards for environmental pollutants
Energy Department	safety and safeguards: DOE contractors
Federal Aviation Administration	establish aviation safety regulations
Federal Highway Administration (Transportation)	establish motor carrier safety regulations

TABLE 8.1. Principal Agencies Involved with Safety Regulation (Cont'd)

Agency	Regulatory Concern
Federal Railroad Administration (Transportation)	establish safety regulations governing railroads and pipelines
Federal Trade Commission	establish consumer product safety regulations (limited)
Fire Research Center (Commerce)	conduct research on prevention and control of fires, including effects on victims
Food and Drug Administration (HEW)	establish regulations governing the safety of drugs, food, medical devices and diagnostic products, biologics; establish regulations governing radiological health
Mine Safety and Health	establish regulations governing worker safety in mining operations
National Highway Safety Advisory Committee (Transportation)	advise Transportation Secretry on highway safety matters
National Highway Safety Bureau (Transportation)	establish regulations governing the safety of highways
National Oceanic and Atmospheric Administration (Commerce)	monitor and detect radiation levels
National Safety Council	promote safety through educational activities
National Science Foundation	conduct research and give advice on safety
National Traffic Safety Bureau (Transportation)	establish regulations governing motor vehicle and tire safety

TABLE 8.1. Principal Agencies Involved with Safety Regulation (Cont'd)

Agency	Regulatory Concern
National Transportation Safety Board	conduct independent accident investigations and formulate recommendations for improved transportation safety
Nuclear Regulatory Commission	safety and safeguards: commercial licensees
Occupational Safety and Health Administration (Labor)	establish regulations governing worker safety
Transportation Department: Materials Transportation Bureau, Office of Hazardous Materials Operations	establish safety regulations governing the transport of radioactive materials by all means and modes except postal shipments
U.S. Postal Service	establish safety regulations governing postal shipments of radioactive materials

In order to interact with safeguards regulations, an agency's safety activities must include regulation and its safety regulations must affect the same people and activities as safeguards regulations. *Therefore all agencies in Table 8.1 that either (1) are involved in safety in some other way than by establishing regulations, or (2) promulgate safety regulations affecting different people and activities than safeguards regulations were excluded from further considerations.* On the first basis, the following agencies were excluded:

- Aerospace Safety Advisory Panel (only gives advice)
- Air Force (only provides information)
- Bureau of Standards (only conducts research)
- Fire Research Center (only conducts research)
- National Highway Safety Advisory Committee (only gives advice)

- National Oceanic and Atmospheric Administration (only provides information)
- National Safety Council (only conducts educational and promotional activities)
- National Science Foundation (only conducts research and gives advice)
- National Transportation Safety Board (only conducts investigations and gives advice)
- Treasury Department's Bureau of Alcohol, Tobacco, and Firearms (affects Tobacco, Alcohol and Firearms)
- Agriculture Department (affects agricultural products)

The following agencies were excluded on the second basis:

- Consumer Product Safety Commission (affects consumer products)
- Federal Aviation Administration (affects aviation)
- Federal Highway Administration (affects motor carriers)
- Federal Railroad Administration (affects railroads and pipelines)
- Federal Trade Commission (affects representations as to product safety)
- Food and Drug Administration (affects drugs, food, medical devices, diagnostic products, biologics, radiological health)
- Mine Safety and Health Administration (affects miners)
- National Highway Safety Bureau (affects highways)
- National Traffic Safety Bureau (affects motor vehicles and tires)

The following agencies' regulations or requirements may interact with NRC licensees but not in the area of health and safety:

- Coast Guard (import and export, transient shipment of nuclear materials by sea)
- U.S. Postal Service (can ship small quantities of nuclear material)
- Defense Department (no health and safety interaction with NRC licenses)
- Energy Department (no health and safety interactions)

This process of exclusion narrowed the focus to those agencies whose regulations affect the same people and activities as the NRC's safeguards regulations--i.e., NRC licensees in the conduct of activities dealing with nuclear material. The relevant agencies are:

- Nuclear Regulatory Commission
- Environmental Protection Agency
- Department of Transportation; Material Transportation Bureau
- Office of Hazardous Materials Operations
- Occupational Safety and Health Administration.

Before proceeding to identification of the relevant regulations, the regulatory concern of each agency is briefly described.

The NRC. Section 161(b) of the Atomic Energy Act of 1954, 42 U.S.C. 2201(b) authorizes the NRC to "establish by rule, regulation, or order, such standards and instructions to govern the possession and use of special nuclear material, source material, and byproduct material as the Commission may deem necessary or desirable to promote the common defense and security or to protect health or to minimize danger to life or property." Protection of health and minimizing danger to life clearly imply regulation to ensure public and worker safety in the possession and use of nuclear materials. Indeed, along with safeguarding nuclear materials, ensuring safety in their use is the central mission of the NRC.(3)

The EPA. Reorganization Plan No. 3 of 1970 created the Environmental Protection Agency, transferring most of the environmental protection functions then exercised by other executive departments and agencies. Among the functions transferred were:

> the functions of the Atomic Energy Commission... administered through its Division of Radiation Protection Standards, to the extent that such functions of the Commission consist of establishing generally applicable environmental standards for the protection of the general environment from radioactive material. As used herein, 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 possessing or using radioactive material.(4)

Thus EPA has the responsibility to promulgate radiation protection standards to protect the public "outside the fence" of nuclear licensees' facilities. In addition, EPA received the functions of the old Federal Radiation Council, by virtue of which EPA is to "advise the President with respect to radiation matters, directly or indirectly affecting health, including guidance for all Federal agencies in the formulation of radiation standards...."(5)

Finally, both The Clean Air Act(6) and the Federal Water Pollution Control Act(7) give EPA authority to regulate radioactive air and water pollutants. (However, while the Clean Air Act expressly includes source, special nuclear, and by-product materials, the Federal Water Pollution Control Act does not, and the Supreme Court has held the Federal Water Pollution Control Act not to apply to such materials.)(8) Thus EPA, like NRC, has statutory authority to regulate the fuel cycle activities of NRC licensees.

DOT. The Department of Transportation Act of 1966 gives DOT "regulatory responsibility for safety in the transportation of radioactive materials by all modes of transport in interstate or foreign commerce (rail, road, air, water), and by all means (truck, bus, auto, ocean vessel, airplane, river barge, railcar, etc.) except postal shipments."[9,10] Currently this authority is lodged in the Materials Transportation bureau, Office of Hazardous Materials Operations. DOE's responsibility for safety in the transportation of radioactive materials affects the shipment of radioactive materials by NRC licensees, a concern shared by the NRC's safeguards regulations.

OSHA. The Occupational Safety and Health Act of 1970 vests in the Department of Labor the responsibility to set mandatory occupational safety and health standards applicable to businesses affecting interstate commerce.[11] This authority is now lodged in Labor's Occupational Safety and Health Administration. Since the Act comprehensively covers every employer who is engaged in a business affecting commerce and who has one or more employees, it too applies to nuclear licensees in the conduct of fuel cycle activities.

8.2 THE REGULATIONS

The NRC, EPA, DOT, and OSHA safety regulations that affect the activities of NRC licensees fall into natural groupings, by and within agencies. As prelude to considering their interaction with NRC safeguards regulations, this section groups and discusses the principal safety regulations of these agencies.

NRC. The major NRC safety regulations are found in 10 CFR Part 19-Notices, Instructions and Reports to Workers; Inspections and 10 CFR Part 20 Standards for Protection Against Radiation. The main requirements and the topic dealt with by each are summarized in Table 8.2.

EPA. As yet, the EPA has not promulgated a large number of regulations pertaining to protection of the environment from radiation. The number of regulations will expand if, pursuant to the study required by the Clean Air Act amendments of 1977, the EPA concludes that emissions of radioactive pollutants contribute to air pollution endangering the public health. For

TABLE 8.2. NRC Safety Requirements

10 CFR Paragraph	Requirement
19.12	Instructions to workers concerning storage, transfer, or use of radioactive materials.
20.101, 20.102, 20.105	Maximum permissible radiation doses to workers.
20.103	Maximum permissible inhalation of radioactive
20.106	Maximum permissible radiation in effluents to unrestricted areas (releases into environment).
20.202	Provision and use of personnel monitoring equipment.
20.203, 20.204	Signs, labels, signals, and controls • Radiation areas to be posted • High Radiation Areas -- Radiation Reduction on Entry, or -- Alarm on entry, or -- Locked -- Exit not to be prevented • 5 rems/hr from sealed source to have additional controls
20.205	Procedures for picking up, receiving, and opening packages.
20.401	Maintaining records of surveys, radiation monitoring, and disposal.
20.402	Reports of theft or loss of licensed material.
20.403	Notification of incidents.
20.405	Reports of overexposure.
70.24	Detection and emergency procedures for criticality accidents.
70.59	Effluent monitoring and recording.

the time being, EPA's Environmental Radiation Protection Standards are confined to those found in Part 190 of Chapter 40 of the Code of Federal Regulations. The key regulations are listed in Table 8.3.

TABLE 8.3. EPA Radiation Safety Requirements

40 CFR Paragraph	Requirement
190.02	Scope: applies to milling, enrichment, fuel fabrication, power generation and reprocessing; excludes mining, waste disposal, transportation and reuse of plutonium.
190.10(a)	Maximum permissible radiation doses to members of general public.
190.10(b)	Maximum permissible quantity of radiation entering environment from U-fuel cycle per gigawatt-year.

DOT. The regulations of the Department of Transportation governing the safe transportation of hazardous materials are contained in 49 CFR Parts 170 through 179. Most pertain to the *shipping* of radioactive materials. Since the shippers of special nuclear, source, and byproduct material will be NRC licensees, the possibility of interaction is obvious. This was indicated in Section 5.3 of the report where the interactions within Part 71 of 10 CFR were discussed. As was shown, it is impossible to address the NRC's shipping and packaging requirements without considering first the DOT's regulations. A few of DOT's regulations also apply to carriers as well. The topics covered by the major requirements, all in 49 CFR, are summarized in Table 8.4.

OSHA. Although the Occupational Safety and Health Act covers all employers in interstate and foreign commerce with no express exception, Section 4(b)(1) of the Act exempts from coverage those working conditions addressed by the regulation of other agencies that affect occupational safety and health.[12] As a result, OSHA's ionizing radiation standards, found in 29 CFR Section 1910.96, do not apply to NRC licensees. (In fact, they are virtually identical to the NRC's worker radiation safety regulations.) However, OSHA's nonradiation-related regulations clearly do apply to NRC licensees in the conduct of their activities. The major regulations that could be relevant, all from Part 1910 of 29 CFR are shown in Table 8.5.

TABLE 8.4. DOT Requirements for Licensees

49 CFR Paragraph	Requirement
173	Package quantity (curies) limits for various radioisotopes shipped in "Type A" or "Type B" packaging.
174.700, 177.842(b) 176.700, 175.700	Maximum permissible dose rates at exterior of packages; minimum separation distances between radioactive materials and people or film.
172	Warning labels on packages.
173.397	Contamination control.
173.391	Shipping papers.
172.204(a)	Shippers' certification.
173.393(b)	Security seal.
173.393(c)	Minimum package dimension.
173.393(g)	Liquid materials to be packaged in leak-resistant container.
173.393(e)	Maximum surface temperatures.
173.393(m), (n)	Quality assurance requirements.
173.389(a), 173.396	Shipment controls for fissile materials: prevent criticality or loss of contents (see also 10 CFR 71 of NRC Regs)
172.204	Certification by shipper.
174.541(b) 177.823(a)(1)	Placarding.
174.750, 171.15,16, 175.45(a)4, 176.48(b), 177,861(a)	Reporting of incidents.
174.24, 175.35, 177.817, 176.24	Shipping papers.

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TABLE 8.5. OSHA Safety Requirements

29 CFR Paragraph	Requirement
1910.12	Construction work.
1910.22	Walking or working surfaces: general requirements.
1910.23	Guarding floor and wall openings and holes.
1910.24	Fixed industrial stairs.
1910.25	Portable wood ladders.
1910.26	Portable metal ladders.
1910.27	Fixed ladders.
1910.28	Safety requirements for scaffolding.
1910.29	Manually propelled mobile ladder stands and scaffolds (towers).
1910.30	Other working surfaces.
1910.37	Means of egress, general.
1910.66	Power platforms for exterior building maintenance.
1910.67	Vehicle-mounted elevating and rotating work platforms.
1910.68	Manlifts.
1910.94	Ventilation.
1910.95	Occupational noise exposure.
1910.97	Nonionizing radiation.
1910.101	Compressed gases (general requirements).
1910.102	Acetylene.
1910.103	Hydrogen
1910.104	Oxygen.
1910.105	Nitrous oxide.
1910.106	Flammable and combustible liquids.
1910.107	Spray finishing using flammable and combustible materials.
1910.108	Dip tanks containing flammable or combustible liquids.
1910.109	Explosives and blasting agents.
1910-110	Storage and handling of liquified petroleum gases.
1910.111	Storage and handling of anhydrous ammonia.

TABLE 8.5. OSHA Safety Requirements (Cont'd)

29 CFR Paragraph	Requirement
1910.132	General personal protective equipment requirements.
1910.133	Eye and face protection.
1910.134	Respiratory protection.
1910.135	Occupational head protection.
1910.136	Occupational foot protection.
1910.137	Electrical protective devices.
1910.141	Sanitation.
1910.143	Nonwater carriage disposal systems.
1910.144	Safety color code for marking physical hazards.
1910.145	Specifications for accident prevention signs and tags.
1910.151	Medical services and first aid.
1910.157	Portable fire extinguishers.
1910.158	Standpipe and hose systems.
1910.159	Automatic sprinkler systems.
1910.160	Fixed dry chemical extinguishing systems.
1910.161	Carbon dioxide extinguishing systems.
1910.163	Local fire alarm signaling systems.
1910.166	Inspection of compressed gas cylinders.
1910.168	Safety relief devices for cargo and portable tanks storing compressed gases.
1910.169	Air receivers.
1910.176	Handling materials--general.
1910.178	Powered industrial trucks.
1910.179	Overhead and gantry cranes.
1910.181	Derricks.
1910.182	Effectives dates.
1910.183	Helicopters.
1910.184	Slings.
1910.212	General requirements for all machines.
1910.219	Mechanical power-transmission apparatus.
1910.241	Definitions: handheld equipment.
1910.242	Hand and portable powered tools and equipment, general.
1910.243	Guarding of portable powered tools.
1910.244	Other portable tools and equipment.

8.3 INTERACTIONS

Having isolated those safety regulations which affect the same people and activities as the safeguards regulations, the next step is to specify the nature of the interactions. This section elaborates on some of the discussion of Chapter 5 wherein the interactions within the safeguards regulations were discussed. The possible interactions are then addressed.

The safety and safeguards regulations are investigated for possible interactions from two points of view;

- *Whether they affect the same set of activities, functions, or objects, and*
- *Whether they affect the same set of people.*

In general, any set of requirements can interact in one of the following ways:

- *No interaction*: Affect different people and activities.
- *Neutral interaction:* Affect the same people and activities in a neutral way (complying with both regulations is just as difficult as complying with each separately).
- *Positive interaction*: Affect the same people and activities in a positive way (complying with both regulations is less difficult than complying with each separately).
- *Negative interaction*: Affect the same people and activities in a negative way (complying with both regulations is more difficult than complying with each separately; in the extreme case, complying with both is impossible).

In specifying the interactions between safety and safeguards regulations, the analysis pairs each safety requirement with each safeguards requirement and classifies the interaction as nonexistent, neutral, positive, or negative. Three steps were followed in considering the possible interactions.

First, the safety and safeguards regulations were arrayed in a matrix, according to the pattern of Figure 8.1. The vertical axis lists the principal safety requirements of the NRC, EPA, DOT, and OSHA, as identified in Section 8.2. The horizontal axis contains the NRC safeguards regulations. Because of the number of regulations involved, many of the safeguards regulations having no obvious interactions were first eliminated from consideration.

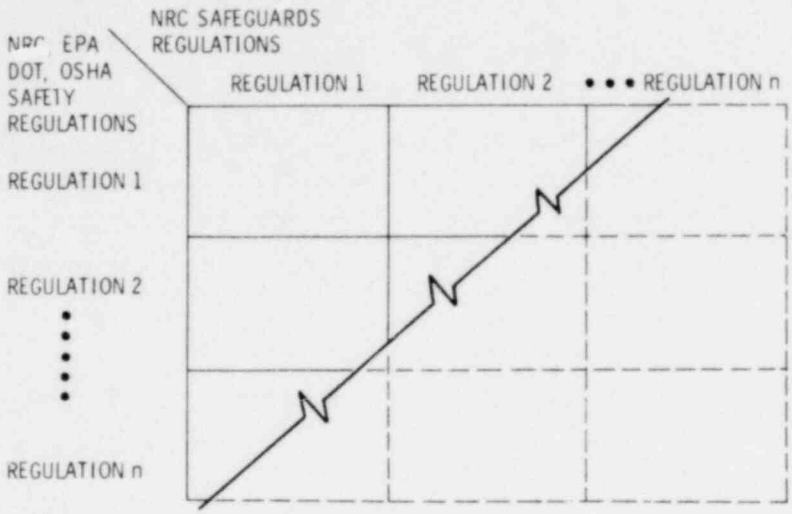

FIGURE 8.1. Form of Matrix for Specifying Interactions

Next, a preliminary comparison of each safety requirement with each safeguards requirement was made to eliminate from further consideration those cells in the matrix corresponding to requirements which do not affect the same people and activities. Also eliminated were those cells affecting the same people and activities that represent neutral interactions.

Recall that the first section of this chapter excluded organizations whose safety regulations affect different people and activities than do the NRC safeguards regulations. Next, Section 8.2 listed the general safety requirements within each organization that may have interactions. Among those general requirements, there still remain safety requirements not likely to affect NRC licensees in the conduct of activities dealing with nuclear material.

On this basis, a number of pairings could be eliminated from further consideration. For example, the NRC safety requirement of providing instructions to workers (Section 19.12) concerning storage, transfer, or use of radioactive materials at most interacts neutrally with the safeguards requirement of keeping records of receipts, inventory, disposal, acquisition, import, export, and transfer (Section 70.51, Paragraph (b)).

The third step was to focus on the nature of the interactions for those pairs of requirements which could not be eliminated by the above comparisons. This required interpretation of the requirements of each pair of regulations. The objective was to specify interactions and isolate instances of conflict (negative interactions). This was complicated for the following reason: while each pair of regulations usually applied to a large number of people and activities, the two regulations often *together* applied to only a small subset of these.

Consider, for example, the pair of regulations illustrated in Figure 8.2. The NRC safety regulation, 10 CFR Section 20.402, concerns reports by all licensees of the theft or loss of source, by-product, or special nuclear material in quantities and under circumstances that pose a substantial hazard to persons in unrestricted areas. The NRC safeguards regulation, 10 CFR Section 70.53(b), concerns reports by licensees authorized to possess over

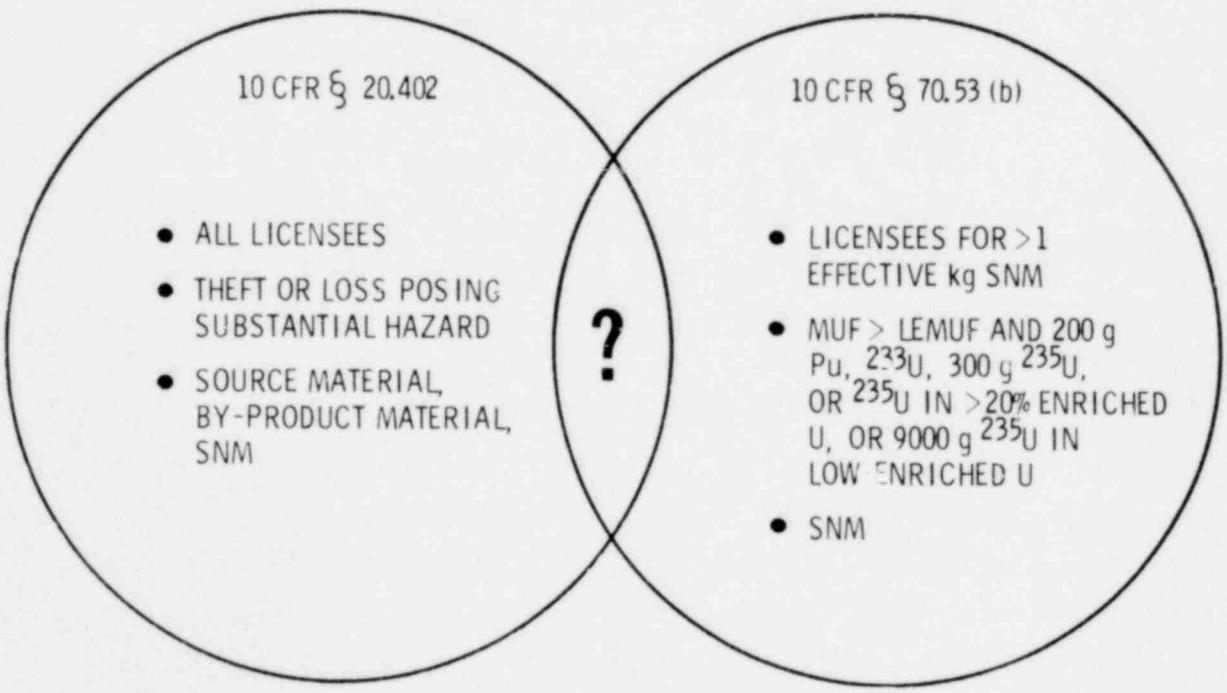

FIGURE 8.2. Applicability of an NRC Safety Regulation and an NRC Safeguards Regulation

one effective kilogram of SNM for specified purposes when material unaccounted for exceeds its associated limit of error plus an additional specified quantity. Both regulations would together apply only when the amount by which the SNM unaccounted for exceeds its permissible limit and poses a substantial hazard to persons in unrestricted areas. Of the limited situations for which both regulations apply, only a smaller subset (perhaps the null set) may involve conflict. Here, the two regulations appear to interact neutrally: they would simply require two different reports to be filed.

The structuring of the safeguards regulations helped reduce the complexity of comparing such pairs of regulations by allowing easy identification of the content and concern of each safeguards regulation. The further analysis of interactions betwen safety and safeguards regulations can best be demonstrated by an example comparison of a pair of regulations. Consider the NRC safeguards requirement that appears in 10 CFR Section 73.30(c), which was reproduced as Figure 3.1 of this report. Also consider the DOT safety requirement that appears in Sections 173.393(b) and (d) of Chapter 40, CFR:

> The outside of each package must incorporate a feature such as a seal, which is not readily breakable and which, while intact, will be evidence that the package has not been illicitly opened. Each radioactive material must be packaged in a packaging which has been designed to maintain shielding efficiency and leak tightness, so that, under conditions normally incident to transportation, there will be no release of radioactive material. If necessary, additional suitable inside packaging must be used.

To help identify the people and activities to which each of the regulations apply three bases were selected to assist the comparison:

Base 3 - Designated Responsible Party
Base 9 - Material Type Classification
Base 11 - Material Measures

For each base, the applicable elements for each regulation were then compared. In Table 8.6, the NRC safeguards regulation applies to the elements marked "N" and the DOT safety regulation applies to the elements marked "D". Note that elements not applicable to either are not included in the table.

TABLE 8.6. Comparison of Two Regulations

Material Type Classification	
N,D	Special Nuclear Material
D	Source Material
D	Strategic Nuclear Material
D	By-Product Material
D	NARM greater than .002 microcuries per g
Quantity of Material	
	Weight
D	Any amount greater than limited quantities set out in 49 CFR Section 173.391
N	5000 g or more as defined in 10 CFR Part 73
Designated Responsible Party	
N,D	Licensee/shipper

Elements covered by both regulation could then be considered. As shown, the two regulations selected here both apply only to a licensee/shipper shipping special nuclear material in the amount of 5000 g or more as defined in 10 CFR Part 73.

The character of the interaction in the situations to which both regulations apply (neutral, positive, or negative) is next determined. In this example, the requirements selected here seem to interact neutrally. The safeguards regulation requires:

- The innermost container to have a tamper-indicating seal
- The outermost container to have a tamper-indicating seal (unless state or local authorities require inspection)
- At least one container (including the vehicle) to be locked.

The safety regulation requires:

- The outermost container to have a tamper-indicating seal or the equivalent
- Packaging adequate (including multiple containers) to ensure that radioactive materials will not be released under normal transportation conditions.

Nothing in one requirement makes it harder (or easier) to comply with something in the other.

This procedure was used to identify the nature of the interactions between pairs of safety and safeguards requirements having possible interactions. Table 8.7 lists the key safeguards requirements that remained after preliminary examination of interactions with the safety regulations. These requirements can be considered as having the greatest potential for negative interaction with the various safety requirements.

With the general categories as numbered in Table 8.7, Table 8.8 compares the various safety requirements that were identified as possibly interacting in a negative manner. At the top of the table, the twenty categories shown in Table 8.7 are given by number. Closed-dot entries in the table represent interactions that were focused on and classified as neutral. Interactions indicated by an open-dot represent those which require further resolution (e.g., in terms of their interpretation) in order to be classified as conflicting.

The following section summarizes the results of this comparison.

8.4 THE EXTENT OF INTERACTIONS

It is possible to eliminate most pairs of requirements from further consideration because they either did not interact at all or obviously interacted in a neutral way. Of the remaining pairs, a similar investigation as described in Section 8.3 found most interacting to be neutral. No positive interactions were found. A limited number of pairs appeared to interact in a negative manner. For those instances of potentially negative interactions two comments are necessary: first, interactions are inferred from the regulations as written. Both the agencies and the licensees may be able to interpret the regulations so that their simultaneous application does not result in conflict. Second, negative interactions are not equivalent to the impossibility of complying with both requirements at once. The presence of a negative interaction only means that complying with both regulations simultaneously is more difficult or costly than complying with each separately. For example, the presence of a safety requirement might force the licensee to

TABLE 8.7. Key Safeguards Requirements that Interact with Safety Requirements

Section	Description
Material Control and Accounting Records	
1. 70.5(b)	Records of receipts, inventory, disposal, acquisition, import, export, transfer.
2. 70.51(c)(i)	Records of tamper-saved items and identity, location, source, disposition.
3. 70.51(e)(i)(iii)	Records of amounts added to or removed from process, amount in process; identify, location and quantity of unique forms.
4. 70.51(e)(4)	Material balance records.
5. 70.57(6)	Measurement control record.
6. 70.58(c)(2), (g)(4), (k)	Fundamental material control records.
Material Control and Accounting Reports	
7. 70.54	Material transfer reports
8. 70.53	Material status reports.
Material Control and Accounting Procedures	
9. 70.51(e)(1)(i)	Tamper saved vaults.
10. 70.51(e)(1)(i)	Unique identification of items and containers.
11. 70.51(e)(1)(v, vi, vii)	Documentation of transfer between MBA's and use of authorized signatures for control of documents.
12. 70.51(d)(e)	Physical inventory.
13. 70.51(e)(4)	Limits on LEMUF.
14. 70.57	Measurement control program (system to monitor control measurement errors).
15. 70.58	Fundamental material controls.
Physical Protection (Facilities)	
16. 50.34(c), 70.22(g) 73.20, 73.40, 73.45	Plan for physical security.
17. 73.46, 73.50, 73.55, 73.60	Security force, barriers, access control, detection, communications, testing and maintenance, response.
Physical Protection (Transit)	
18. 73.20, 73.25, 73.30 73.72	Protection by carrier, plans, container scale, guards, notification, and reports.
19. 73.26, 73.31-73.34	Transit modes.
20. 73.26, 73.35	Continuous monitoring.

TABLE 8.8. Interactions Between Safety and Safeguards Requirements

SECTION	NRC SAFEGUARDS REGULATIONS (NUMBERS CORRESPOND TO TABLE 7.7)
NCR SAFETY REQUIREMENTS (10CFR) (SEE TABLE 7.2)	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
19.12	
20.101, 20.102, 20.105	
20.103	
20.203, 20.204	
20.205	
20.402	
20.403	
20.405	
70.24	
EPA ENVIRONMENTAL RADIATION PROTECTION STANDARDS (40CFR) (SEE TABLE 7.3)	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
190.10(a)	
190.10(b)	
DOT RADIOACTIVE MATERIALS TRANSPORTATION (49CFR) (SEE TABLE 7.4)	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
173	
174.700, 177.842(b), 176.700, 175.700	
172	
173.397	
173.393(b)	
173.393(c)	
173.393(g)	
173.393(e)	
173.393(m), (n)	
173.389, 173.396	
174.541(b), 177.823(a)(i)	
177.750, 171.15, 16, 175.45(a)(4)	
176.48(b), 177.861(a)	
174.24, 175.35, 177.817, 176.24	
OSHA STANDARDS (29CFR) (SEE TABLE 7.5)	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
1910.36	
1910.37	
1910.144	
1910.145	
1910.163	

employ two guards rather than one in complying with a safeguards requirement. The following observations regarding interactions are grouped by each organization having safety requirements.

Nuclear Regulatory Commission

The NRC's safety requirements appear relatively free of conflict with its safeguards requirements. While virtually all of the safety requirements interact with the safeguards requirements in that both sets affect NRC licensees, almost all the requirements interact neutrally. Complying with safety and safeguards requirements together appears little more difficult than complying with each set of regulations separately.

Several potentially negative interactions, however, were found. All involved possible conflict between NRC safety requirements and the physical protection requirements of Part 73. Safety requirements appeared not to conflict with material control and accounting requirements in Part 70.

The potential conflicts include:

- the possibility that limits on radiation doses could complicate physical security arrangements (e.g., by requiring frequent changes of personnel);
- the possibility that the requirement for uninhibited exit from high radiation areas could impede the capture of saboteurs;
- the possibility that the requirement for immediate notification of theft, loss, or accidents could delay SNM transfers, which must be continuously monitored;
- the possibility that detection and emergency procedures for criticality accidents could complicate physical security arrangements.

These are only possible conflicts; current interpretation of the requirements may eliminate their conflicting interactions.

Environmental Protection Agency

EPA's radiation standards appear to interact with the NRC's safeguards regulations in an entirely neutral manner. EPA's standards set maximum permissible radiation doses to members of the general public and a maximum permissible quantity of radiation entering the environment. In essence,

these requirements limit the effluents NRC licensees can allow to escape through boundaries of their facilities.

The analysis did not completely eliminate the possibility of negative interactions--it seemed that these requirement might constrain physical protection arrangements for materials in transit or at fixed facilities--the detailed analysis pointed to no negative interactions.

Department of Transportation

DOT's requirements apply to NRC licensees whenever they ship source, special nuclear, or byproduct material. In Section 71.5, however concerning general transportation requirements, the DOT regulations take priority over packaging requirements set forth in Part 71.

Occupational Safety on Health Administration

As previously noted, OSHA's ionizing radiation standards are not directly applicable to NRC licensees; the protection of workers from radiation is the responsibility of the NRC itself. OSHA's many nonradiation-related standards do apply to NRC licensees. However, while these requirements in principle apply to the same people as safeguards regulations, many do not apply to activities in which NRC licensees are typically engaged. *Therefore, a large number of OSHA standards do not interact at all with safeguards requirements.*

Of those that do interact, almost all appear to do so neutrally. The small number that may interact negatively are those which could possibly impede compliance with physical protection requirements. These include:

- egress requirements (which could make it harder to capture an intruder),
- color code markings for physical hazards (which could ease the tasks of saboteurs),
- accident prevention signs and tags (which could also provide useful information to saboteurs).

The potential conflict between safety and safeguards regulations appears quite limited. Many of the regulations affect different people and activities and so do not interact at all. Of the remainder, most interact neutrally,

compliance with safety and safeguards requirements together is no more difficult than complying with each separately. Of the very small number of requirements that have the potential to interact negatively, the language of the regulations alone is not sufficient to gauge the magnitude of conflict, if any, in actual practice.

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4. 84 Stat. 2806.

5. 42 U.S.C. 2021(h), Reorganization Plan No. 3 of 1970, Sec. 2(7).

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12. 29 U.S.C. 653(b)(1).

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The publication presents systematic analysis methods which are used to assess the content and relative coverage of the physical protection and material control and accounting regulations, contained in 10 CFR Parts 50, 70, 71 and 73. Specifically, the regulatory requirements are examined to determine if they are (1) responsive to safeguards policy, (2) consistent, (3) complete, and (4) do not contradict or render ineffective other safeguards requirements, public safety requirements, or worker safety requirements.

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