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Safeguards Information System Flows Associated With the Plant Safeguards Authority (U)

John C. Schleter

Institute for Applied Technology
Technical Analysis Division
National Bureau of Standards
Washington, D. C. 20234

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U. S. DEPARTMENT OF COMMERCE, Frederick B. Dent, Secretary

NATIONAL BUREAU OF STANDARDS, Richard W. Roberts, Director

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ABSTRACT

Increasing use of nuclear material imposes additional emphasis on safeguards. The Technical Analysis Division, NBS, has been assisting the AEC in performing systems studies directed to safeguards for nuclear materials. A Safeguards Information System (SIS) is being developed so as to provide the information and decision structure needed for assurance that significant diversion to unauthorized use has not occurred in the past and, further, that any significant diversion which might in future occur will be detected in a timely manner. Although a comprehensive report is in preparation, a preview is considered useful at this time in order to familiarize plant personnel, charged with development of plant safeguards information systems, with aspects of SIS. This report thus reflects material from the forthcoming report and directs attention to the information flows related to the key safeguards decision maker within the plant - the plant safeguards authority. Terms and concepts are defined and their application is illustrated in the general case by highlighting decision responsibilities and details of the safeguards information flows associated with him.

INTRODUCTION

Of constant concern to the AEC is the possibility of illicit removal of special nuclear material (SNM) from authorized to unauthorized use. Such removal is termed diversion, and should it occur, attention is directed to the location where the SNM was last accounted for. Focus is thus on plants, laboratories and transportation activities for each provides the potential diverter with direct access to SNM. The plants are of particular interest due to the quantity of SNM generally on hand and the many varied opportunities made available to the diverter by virtue of the complexity and size of plant operations.

In order to minimize the possibility of diversion, consideration must be given in advance to the various facets of the problem and, in particular, to the methods by which material might be diverted and to the techniques by which diversion might be detected. One common thread for unraveling this complex problem is the flow of information between personnel having decision responsibility for safeguards. Adequate information, when coupled with plant implementation experience, leads to the design of a plant safeguards system which serves as one mechanism for rapid diversion detection.

Forethought of the roles of the various decision makers permits characterization of the information flows and allows one to make statements concerning the information to be contained in such flows. To this end, the Technical Analysis Division, NBS, has been assisting the AEC in developing a Safeguards Information System (SIS) so as to provide the information and decision structure needed for assurance that significant diversion has not occurred in the past and, further, that any significant diversion which might in future occur will be detected in a timely manner.

This report reflects portions of a forthcoming comprehensive report "Framework of the Safeguards Information System (SIS)" [1] which is currently being completed in greater detail and broader scope. The intent here is to provide an example for designing plant systems by highlighting the information flows associated with only one of the decision makers of safeguards, the plant safeguards authority. Within the structure of SIS, he is responsible for design and review of the plant safeguards information system and is the focal point of plant safeguards activities; most types of information flows identified during the development of SIS therefore involve him in one way or another. These information flows may provide plant personnel with an understanding of the aspects of a generalized information system and the description of their derivation may serve as a guide when design of a plant-specific system is undertaken. In essence, this report provides a background for understanding the SIS concept, illustrates the procedure for its application and culminates in a complete description (in detailed outline form) of the information needs and flows of this key safeguards decision maker.

1. ASPECTS OF AN INFORMATION SYSTEM

In order to develop and describe the detailed structure or framework of an information system, be it the general SIS or a plant-specific SIS, it is first necessary to understand, identify and state (precisely and accurately) the objectives of the system. The objectives, in turn, must reflect the goals of the activities which the information system is intended to serve. For safeguards, the goal is protection of the public and assurance with regard to threats from unauthorized diversion of SNM; the objectives of a SIS concern provision of information in event of diversion or valid assurance that diversion has not, in fact, occurred. It remains to identify the system elements which comprise a SIS and to determine their relationships.

To be effective, SIS must be extensive and comprehensive in terms of spatial and temporal coverage and with respect to numbers of people and types and amounts of information. It is therefore necessary to conduct a logical breakdown and examination of system elements and their interrelationships to ensure that system objectives are achieved. Some concepts which are usually associated with information system analysis are useful in giving adequate consideration to each element so that none is overlooked. In particular, the concepts of nodes and flows together with content of nodes and purposes, methods and content of flows have been found to be useful.

1.1 Nodes

In the context used here, the concept of nodes encompasses:

- physical locations, such as an AEC Field Office, a plant or a sub-unit of a plant;

- decision points or decision makers within locations where safeguards decisions[1] are reached as to the existence of abnormal situations[2] and the status of design, modification and operation of the safeguards system;
- analysis points or analysts within locations where SIS analysis is performed;
- sources within locations where data and information are generated (data sources and information sources); and
- activities performed at locations, principally of a review nature, such as surveys and inspections.

The content of nodes refers to documentation maintained in the node and includes:

- records and reports, either manually prepared or computer generated (using data elements accruing in this or another node);
- files in the form of papers, computer cards ("punched" cards), or magnetic-tapes, - drums or -disks;
- logs prepared in this or another node; and
- procedure manuals prepared in this or another node.

1.2 Flows

The concept of flow refers to the transmittal of data and information from an origin to a destination, that is, between any two nodes. A flow involving an intermediate node can be considered as two separate flows of the same information or data, where the intermediate node is the destination on the one hand and the origin on the other. There are three important aspects of a flow: purpose, method, and content.

The purpose of flow refers to the reason for the transmittal and divides flows into two types:

- reporting flows, the contents of which serve as the basis for actions or decisions; and
- administrative flows, which serve only to inform.

The methods of flow fall into two genral classes:

- oral flows include direct conversation between individuals or other means of voice communication, such as telephone or radio; and
- written flows consist of hardcopy reports (either manually prepared or computer generated), Teletype (TTY) messages, output from data links and computerized video displays (CRT displays).

The content of flows include:

- data elements such as
  - measurements and
  - identifications;

---

[1] "Decisions" include all responsibilities for safeguards actions.

[2] An "abnormal situation" means an occurrence inconsistent with that expected which can be related to possible diversion.

- information elements, for example,
  - processed data of any type, including
    - mental computations,
    - aggregations,
    - comparative analyses, and
    - statistical analyses,
  - observations
  - probabilities,
  - evaluation of probabilities
  - historical perspective,
  - conclusions, and
  - assurance statements;
- alerts; and
- alarms.

The relationships of flows among nodes can best be represented schematically. A general set of symbols has been adopted (given in figure 1) for the entities described above, and many of them are used in the schematic diagrams appearing later in this report; all are used in the comprehensive report. [1].

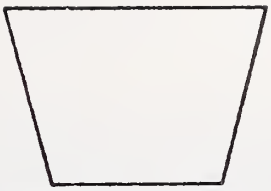
2. THE DECISION STRUCTURE

The safeguards system is composed of a great many decision makers who, depending upon their relative position within the system, may be called upon or be responsible for a number of different types of judgments. In order to comprehend the information flows associated with the plant safeguards authority, it is necessary to place him in proper context among the decision makers and identify those with whom he interacts.

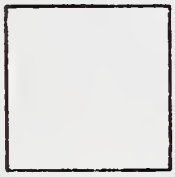
Before doing this, however, a brief discussion of safeguards decisions is in order. The decisions reached by cognizant personnel, based on information made available through SIS, allow statements about diversion to be made with assurance (e.g., that diversion has not taken place in the past, or that, should diversion occur in future, indication will be given in timely manner). Decisions, may, for example, be related to abnormal situations, timely indication or the adequacy of available information, to name but a few. All decisions contribute toward the confidence given to the public that the safeguards system is working.

Each decision maker contributes an assessment of whether or not the system is adequate in meeting safeguards goals for his level of responsibility and for those levels subordinate to him. Thus, decisions made at each level serve as inputs for statements related to assurance, generally made at higher levels in the system. For purposes of SIS, decision responsibilities may be divided into two types: those pertaining to system operation and those pertaining to system design and modification. The former include recognition of any abnormal situations which develop and also determination that the system is operating properly as a matter of routine. Such responsibilities properly fall to those within the plant who oversee daily operations. System design and modification responsibilities entail judgment of the adequacy of procedures and performance of the system for satisfying safeguards goals and are the province of management.

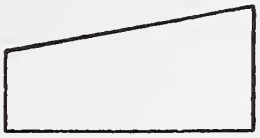
LOCATION



INSPECTION ACTIVITY



INFORMATION OR
DATA SOURCE



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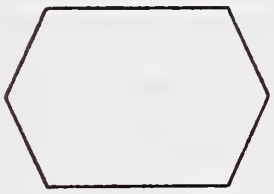
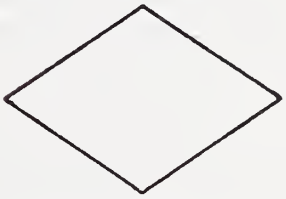


ANALYSIS POINT



DECISION POINT OR PERSON
MAKING DECISION

ORAL INFORMATION FLOW

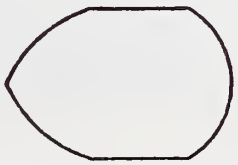
WRITTEN INFORMATION FLOW

ORAL OR WRITTEN INFORMATION
FLOW (AT FACILITY OPTION)

ADMINISTRATIVE INFORMATION
FLOW

HARDCOPY REPORT

FILES AND LOGS OF INFORMATION
OR DATA (PAPER, CARD OR MAGNETIC)



COMPUTERIZED VIDEO DISPLAY
(CRT DISPLAY)

Figure 1 SIS Framework Symbols

As will be seen, the latter are primary decision functions of the plant safeguards authority. (Additional decision functions are described in a latter section). Although each decision maker within the system has specific decision functions, the purposes of this report do not require that they be detailed here. The nature of the decisions required of the decision makers, however, govern the detailed content of the nodes and establish the specific methods and content of the information flows.

Decision makers are identified and listed in Table 1, grouped into the following categories: the process line, storage, shipping and receiving, transportation, others with SNM access, physical security and management. As one descends through these groups, the accessibility and directness of information concerning items of SNM subject to diversion increases. Several secondary decision makers are included in the table for completeness. These decision makers are located at the management level, and their activities do not primarily address safeguards functions. They are, however, informed of any abnormal situations and may be called upon to make administrative decisions with regard to such a situation.

In a given facility, one individual may have decision-making responsibilities ascribed in this report to more than one decision maker. Further, the term decision maker refers not only to the individual having ultimate responsibility for a given set of safeguards decisions but also to members of his staff who contribute to his decision making functions. Organizational structures differ among facilities, hence the titles used in this report may not apply universally; in a specific plant personnel must be related by means of significant tasks and responsibilities to the generic titles used here.

Figure 2 emphasizes the relationships among decision makers, the data sources and information sources. Data sources for decisions, indicating proximity or detailed information about specific items of SNM, are shown near the bottom of the figure. Above each data source is shown the relative level of decision maker or analysis associated with it. The vertical relationship of the decision structure to the data sources as shown in Figure 2 applies through the plant management level. Above that level, however, decision makers are concerned with broader groupings of data sources, such as several facilities within a field office or several field offices.

Table 1 and Figure 2 locate the organizational position of the plant safeguards authority within the safeguards decision making hierarchy.

3. CONCEPTS EMPLOYED IN SIS

During the evolution of the general SIS, concepts of the unit process, a logic of response to abnormal situations and diversion path analysis were developed. These concepts have become integral components of the information flows associated with the plant safeguards authority, as well as all decision makers of the system, and a brief statement of each concept is, therefore, essential to full understanding of the information flows described later in this report.

MANAGEMENT
- THE PRESIDENT
- THE JOINT COMMITTEE ON ATOMIC ENERGY (JCAE)
- THE ATOMIC ENERGY COMMISSION (AEC)
- AEC GENERAL MANAGER
- AEC ASSISTANT GENERAL MANAGER FOR NATIONAL SECURITY, HEADQUARTERS
- AEC DIRECTOR OF REGULATION, HEADQUARTERS
- AEC DIRECTOR, DIVISION OF SAFEGUARDS AND SECURITY, HEADQUARTERS
- CHIEF, INTERNAL SECURITY BRANCH, HEADQUARTERS
- CHIEF, MATERIALS AND PLANT PROTECTION OPERATIONS BRANCH, HEADQUARTERS
- AEC APPRAISER, HEADQUARTERS
- FIELD OFFICE MANAGER
- FIELD OFFICE SOURCE AND SPECIAL MATERIALS REPRESENTATIVE (SS REP)
- FIELD OFFICE DIRECTOR OF SECURITY
- AEC SURVEY INSPECTOR, FIELD OFFICE
- AEC SECURITY INSPECTOR, FIELD OFFICE
- REGIONAL TRANSPORTATION CONTROL
- PLANT MANAGER
- PLANT SAFEGUARDS COMMITTEE
- PLANT SAFEGUARDS AUTHORITY
- PLANT PRODUCTION CONTROL MANAGER
- PLANT PHYSICAL SECURITY DIRECTOR

PHYSICAL SECURITY
- PLANT GUARD CAPTAIN
- PLANT GUARD

R&D AND LABORATORY
- R&D AREA SUPERVISOR
- R&D AREA SNM CUSTODIAN
- R&D AREA TECHNOLOGIST
- ANALYTICAL LABORATORY SUPERVISOR
- ANALYTICAL LABORATORY SNM CUSTODIAN
- ANALYTICAL LABORATORY CHEMIST

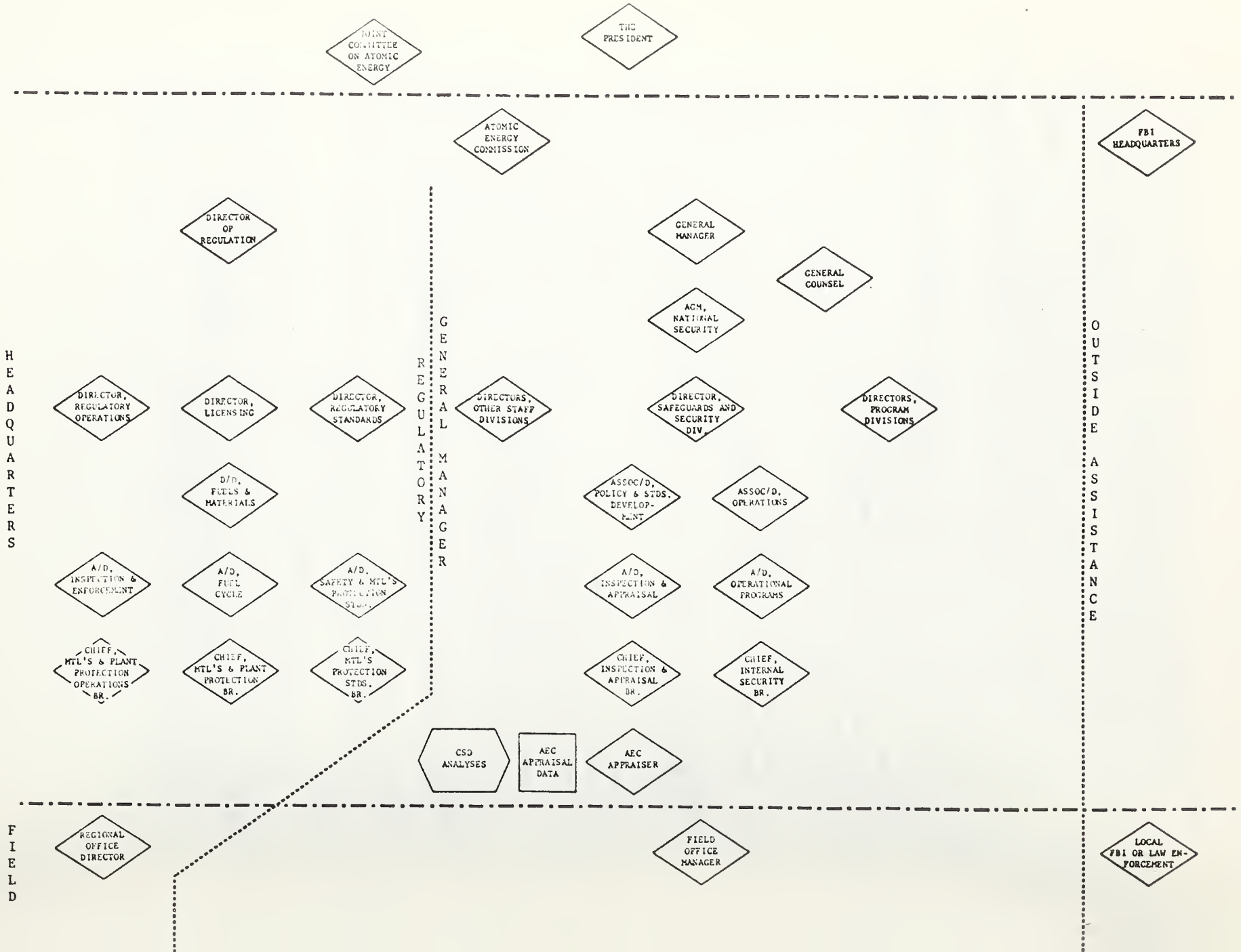
TRANSPORTATION
- SNM TRANSPORTATION CUSTODIAN–DRIVER OR COURIER

SHIPPING AND RECEIVING
- SHIPPING DOCK FOREMAN
- SHIPPING DOCK CLERK

STORAGE
- PLANT PHYSICAL INSPECTOR
- VAULT MANAGER

PROCESS LINE
- PROCESS ENGINEER–UNIT PROCESS OR MATERIAL BALANCE AREA
- SNM CUSTODIAN–MATERIAL BALANCE AREA
- PROCESS FOREMAN–MATERIAL BALANCE AREA
- PROCESS OPERATOR–UNIT PROCESS

Table 1 The Safeguards Decision Makers


JOINT COMMITTEE ON ATOMIC ENERGY
THE PRESIDENT
ATOMIC ENERGY COMMISSION
FBI HEADQUARTERS
DIRECTOR OF REGULATION
GENERAL MANAGER
GENERAL COUNSEL
ACM, NATIONAL SECURITY
HEADQUARTERS
REGULATORY
GENERAL MANAGER
OUTSIDE ASSISTANCE
DIRECTOR, REGULATORY OPERATIONS
DIRECTOR, LICENSING
DIRECTOR, REGULATORY STANDARDS
DIRECTORS, OTHER STAFF DIVISIONS
DIRECTOR, SAFEGUARDS AND SECURITY DIV.
DIRECTORS, PROGRAM DIVISIONS
D/D, FUELS & MATERIALS
ASSOC/D, POLICY & STDS. DEVELOPMENT
ASSOC/D, OPERATIONS
A/D, INSPECTION & ENFORCEMENT
A/D, FUEL CYCLE
A/D, SAFETY & MTL'S PROTECTION STDS.
A/D, INSPECTION & APPRAISAL
A/D, OPERATIONAL PROGRAMS
CHIEF, MTL'S & PLANT PROTECTION OPERATIONS BR.
CHIEF, MTL'S & PLANT PROTECTION BR.
CHIEF, MTL'S PROTECTION STDS. BR.
CHIEF, INSPECTION & APPRAISAL BR.
CHIEF, INTERNAL SECURITY BR.
CSD ANALYSES
AEC APPRAISAL DATA
AEC APPRAISER
FIELD
REGIONAL OFFICE DIRECTOR
FIELD OFFICE MANAGER
LOCAL FBI OR LAW ENFORCEMENT

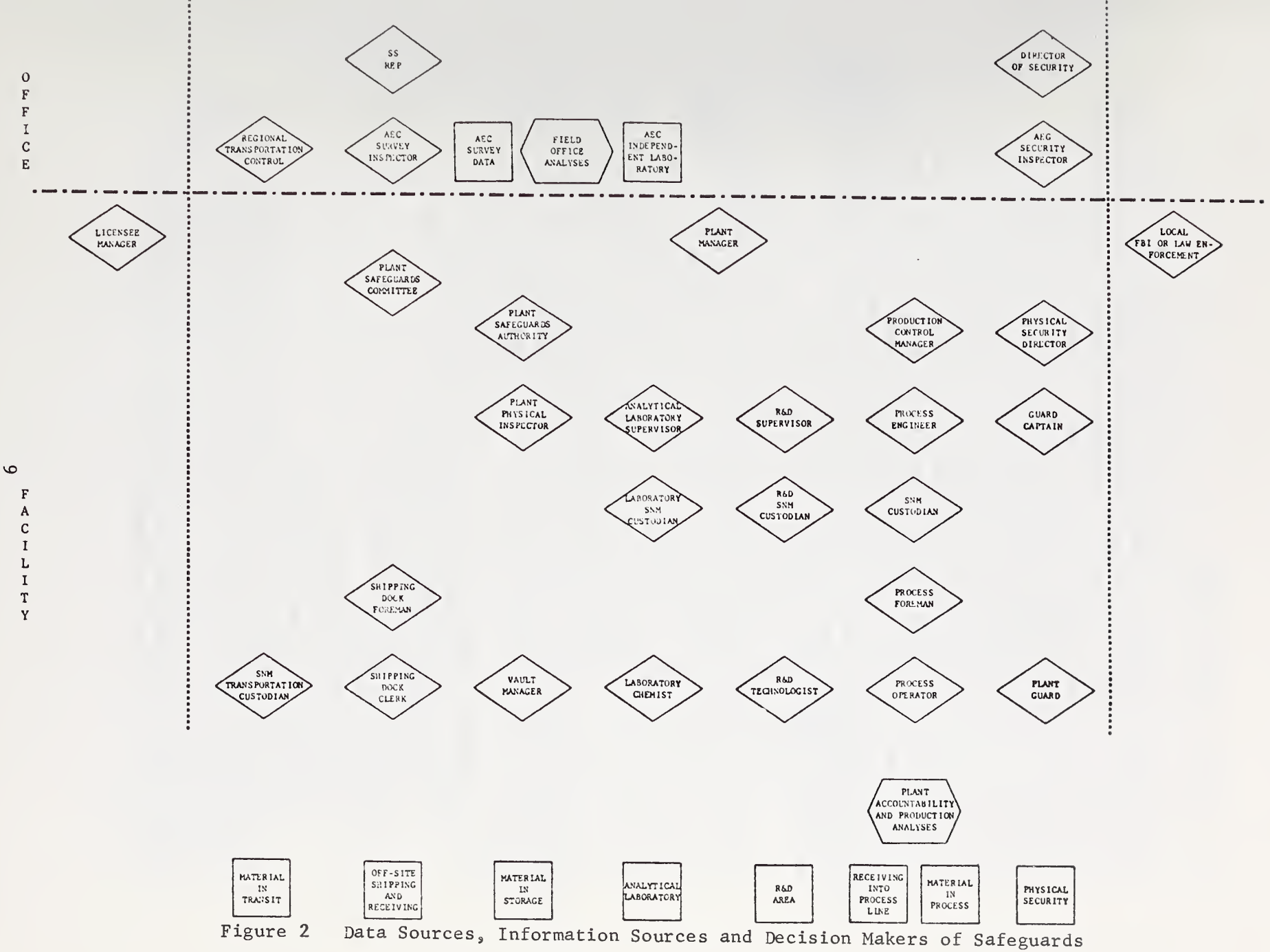


Figure 2 Data Sources, Information Sources and Decision Makers of Safeguards

3.1 The Unit Process Concept

The unit process is the basic "building block" for SIS design. Nuclear plant processes are complicated, involving material flows dependent on many variables and usually unique to a given plant. Consequently, in order to perform a systematic safeguards analysis for a given plant, its material flows and data variables must be characterized. It then becomes possible to apply analytical techniques to large industrial facilities, such as nuclear plants,where plant operator processes and procedures are complex, highly interrelated and constantly changing. Early in the SIS evolution, it was found that many processes could not be adequately analyzed because the available variables did not permit relating material flows to one another. The typical problem stemmed from attempts to examine data from too large a portion of the process. Also, it was noted that the lack of information about unmeasured recycle strongly affected data related to material flows external to the portion of the process under study. The unit process concept was developed to overcome these problems, helping to achieve modular construction of an arbitrary nuclear plant from the standpoint of SIS.

In this concept the overall process stream of a plant is subdivided into many smaller operations (the unit processes), each of which introduces a "branch point" in the process stream, a location where material changes its physical or chemical form or composition, or where a by-product is generated (e.g., recycle, scrap or waste). The combination of two sources of feed material into a single product or the machining of a casting, producing product and scrap, are examples of activities within simple unit processes. More types of material flows may be involved, the key to the concept being that each flow can be well characterized in terms of material quantity, quality and destination. Nine types of material flows (illustrated schematically in Figure 3) are identified in relation to the general unit process; all flows need not be utilized in the operations of a specific unit process. The nine types are:

- feed (from the preceding unit process or plant storage);
- product (to the next unit process or plant storage);
- recycle (characterized feed-back within a unit process);
- recycle from another unit process;
- recycle to another unit process;
- scrap to recovery;
- waste to measured discard;
- samples to the laboratory; and
- material unaccounted for (MUF).

The modular aspects of the unit process concept as applied to a hypothetical plant is illustrated in Figure 4. In this example, it is observed that the scrap recovery areas, S.1 through $S.n_S$, do not involve all possible flows. Further, it is seen that a number of unit processes combine to form a single material balance area (MBA), usually considered (by the AEC) as the smallest sub-unit within a plant for purposes of accounting and inventory information.

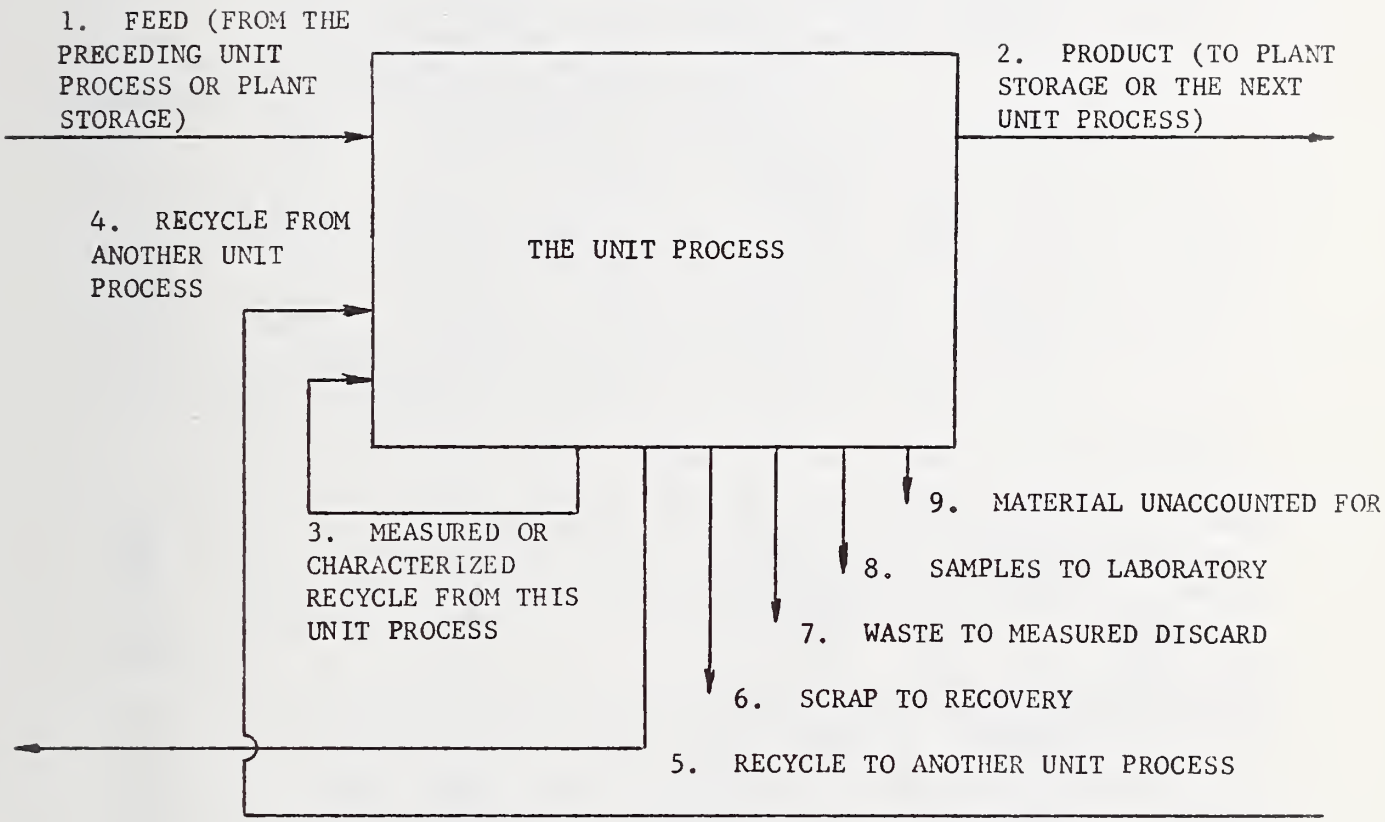


Figure 3 Unit Process Material Flows

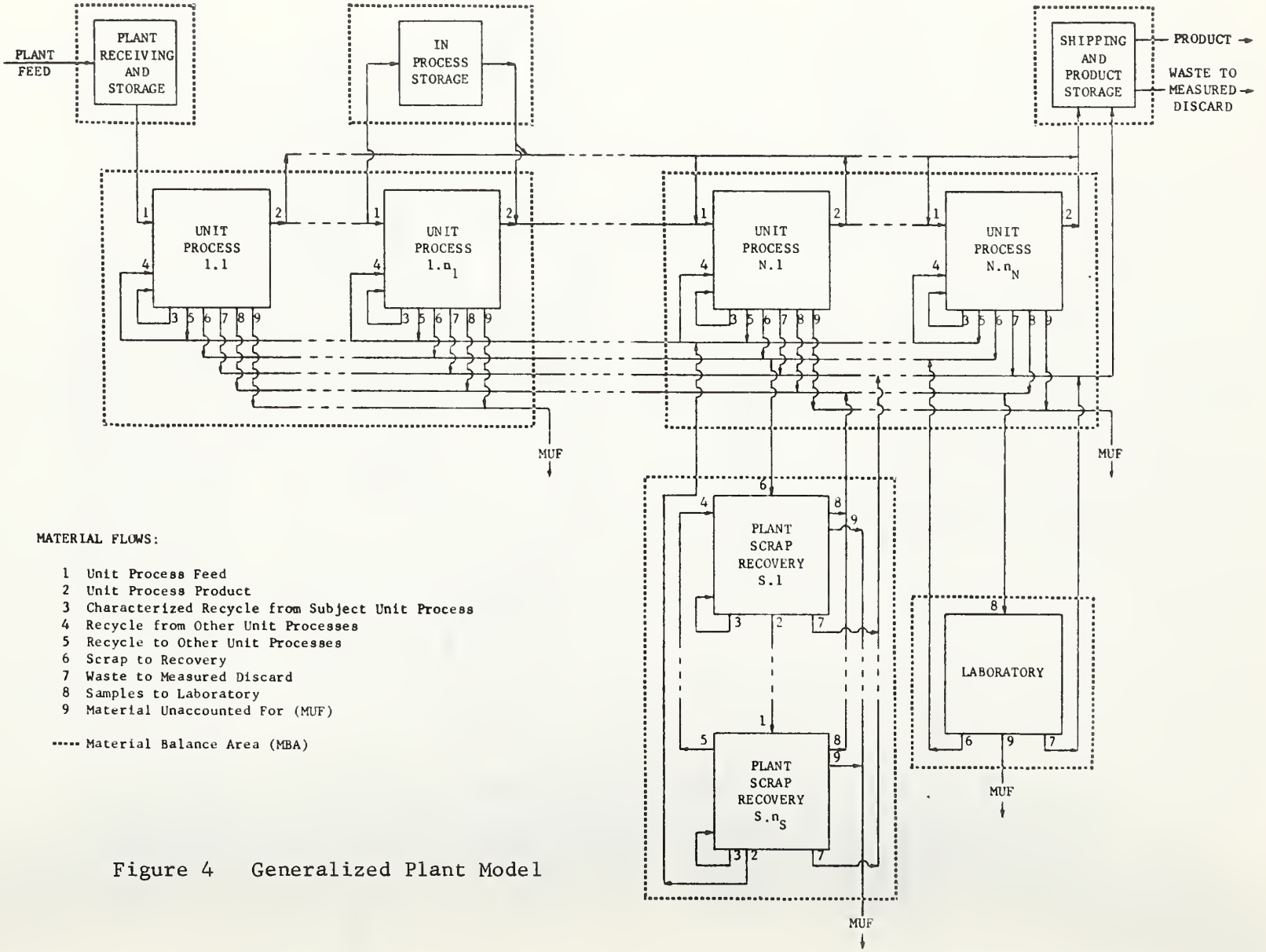


Figure 4 Generalized Plant Model

3.2 Logic of Response to Abnormal Situations

This concept suggests a set of guidelines which might be implemented as policy for directing response to observed abnormal situations. There are four principle ideas incorporated in this concept:

- o two-level reporting;
- o resolution feedback;
- o the abnormal situation log; and
- o the elapsed time clock.

A logic diagram of the interrelationship of these principles for decision and action steps in the face of an abnormal situation is illustrated in Figure 5. The levels "n", "n+1" and "n+2" of Figure 5 refer to a set of relative action levels of decision makers in the safeguards decision structure (Figure 2). The cognizant decision maker to be identified at each level is determined by the abnormal situation reporting flow for each data source, shown superimposed on the decision structure in Figure 6, and the time required for resolution. As an example, for the "material in process" data source at discovery of an abnormal situation, observation and subsequent action rests with the process foreman (level "n+1") and review and administrative follow-up with the process engineer (level "n+2"). If the abnormal situation is unresolved within prescribed time, additional resources must be called. For this round of investigation, level "n" shifts to the process foreman, level "n+1" to the process engineer and level "n+2" to the plant safeguards authority. Each call for additional resources reflects the increased seriousness of delayed resolution and brings the next higher decision maker and his information to the investigative team.

Two-level reporting is the thesis that any abnormal situation be reported not only to the logical, immediate supervisor (who is required to take necessary action), but also to the next higher echelon. This has the effect of insuring that action is taken in an abnormal situation and that action is not delayed in hopes of resolution. Moreover, with two-level reporting, a scattering of abnormal situations throughout a plant, each not especially unusual in its area, will not go unnoticed in the aggregate.

Resolution feedback is important not only for the obvious functional purpose of terminating lower level response when the apparent abnormality was caused innocently, but also for deterrence, yet another goal of safeguards. That is, the system response is believably demonstrated to individuals at lower levels and they became aware that action is taken in reply to a report of an abnormal situation. In contrast, the belief that an abnormal situation will be ignored encourages the tendency either to fail to report the abnormal situation or to assume that others will fail to report, making it possible to divert material without getting caught.

The abnormal situation log is kept by each decision maker at the facility level, (see Figure 2) except the plant manager and the plant safeguards committee. It is a record of each abnormal situation occurring in a data source over which the decision maker has cognizance. It includes references to the data which first indicated the abnormal situation, all

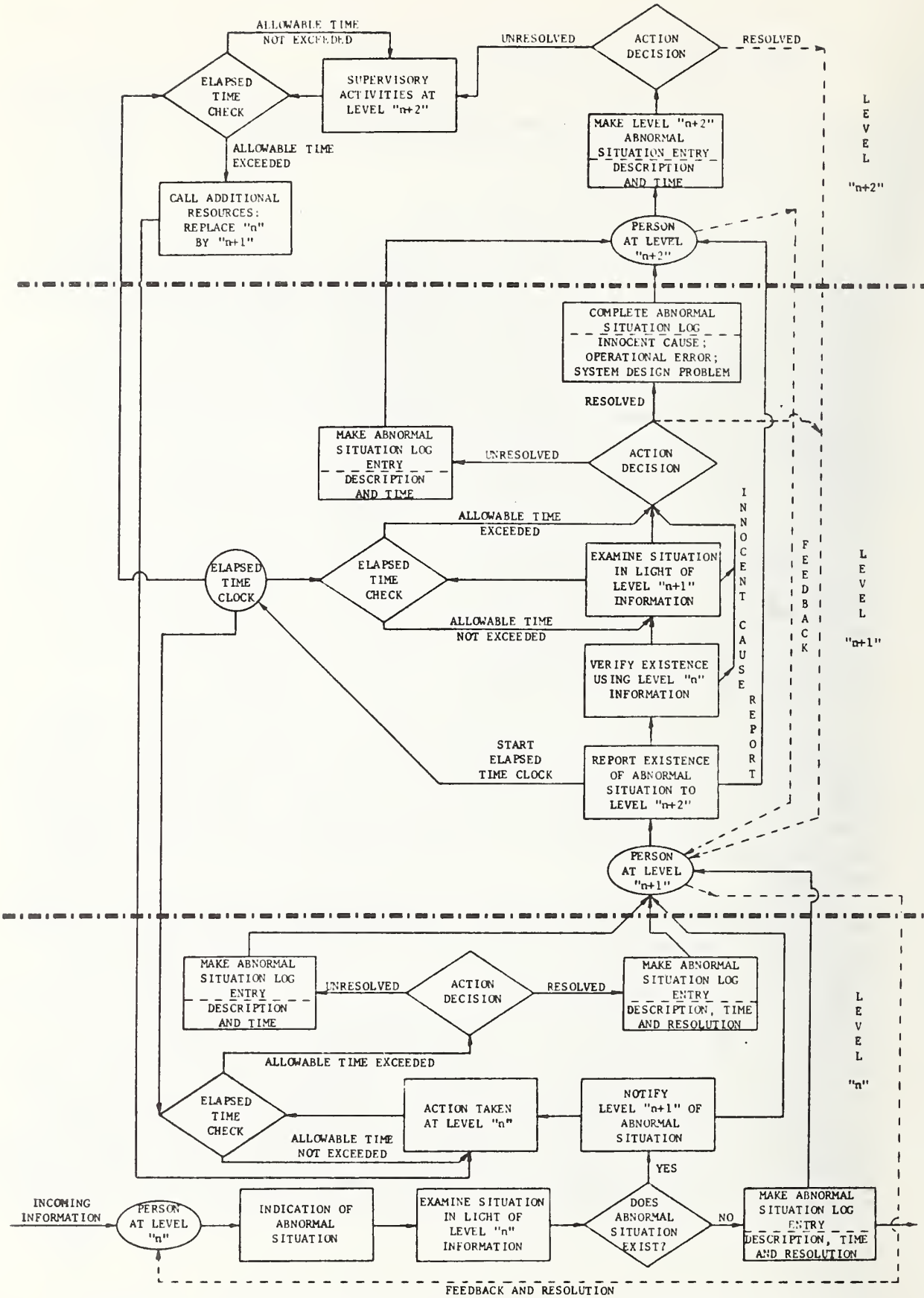


Figure 5 Logic Diagram for Actions Related to Abnormal Situations

pertinent dates and times, the response and the resolution of the situation. Innocent causes of abnormal situations are also listed, and should the indication be due to an error in system design or to a process-related problem, this will become apparent. The system can then be modified for improved handling of indications from innocent causes in the future. When within the purview of the decision maker, recommendations for solutions to system design problems should also be included in the log.

The records maintained as the abnormal situation log are essential for evaluation of the system and are fundamental to modifications of its design. It contains key evidence that the system is functioning at a given location and helps to give assurance for reporting of future abnormal situations. A pattern of abnormal situations traceable to a given individual or processing areas will also become apparent so that corrective action can be taken.

The "elapsed time clock" effectively restricts the total time, ET_n, to be allowed for investigation, establishment of an innocent cause, or resolution of an abnormal situation before additional action must be taken. At a given level "n" (as shown in Figure 5), this maximum allowable time may be characterized as:

$$ET_n = f(MA, S_M, S_T, S_S, n),$$

where

MA = material attractiveness[3],

S_M = mass sensitivity[4],

S_T = time sensitivity[5],

S_S = space sensitivity[6], and

n = cognizant person or decision level.

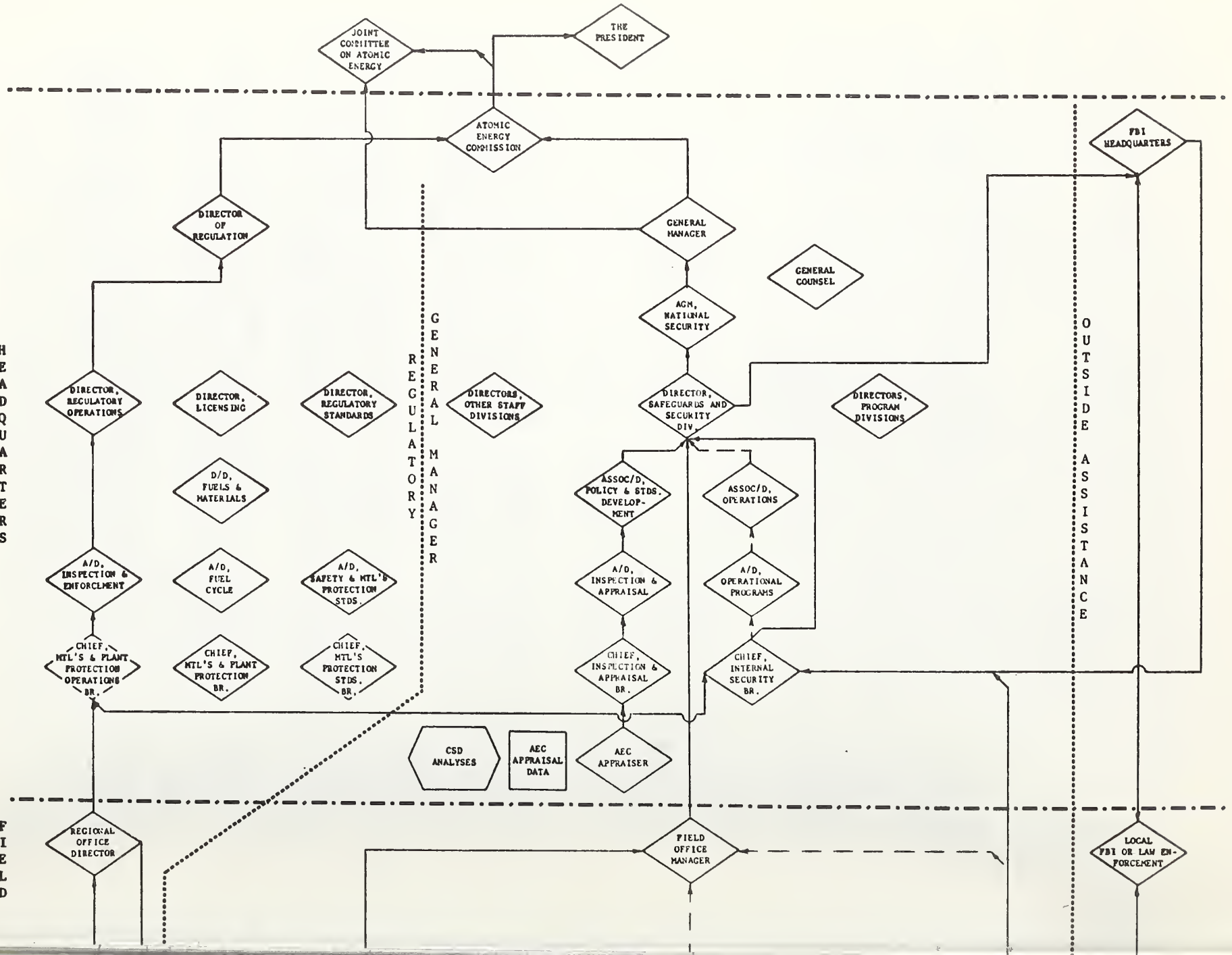
---

[3] A means of expressing the idea that when several material types (i.e., the nuclear properties of the SNM) or descriptions (i.e., the physical or chemical form of the SNM as distinguished from material type) are subject to illicit removal from an area, some may be more desirable to a diverter than others because of the ready or easy adaption to intended end-use.

[4] An attribute of diversion indication for denoting that in the event of a diversion of a threshold mass of X grams, there is at least a p% probability that a signal in the information (i.e., an abnormal situation) will result which will serve to initiate additional investigation. Also, the specification of the quantity of the threshold mass.

[5] An attribute of diversion indication for denoting that in the event of diversion, there is at least a p% probability that there will be a signal in the information (i.e., an abnormal situation) observed wthin d days. Also, the specification of the time interval within which observation should occur.

[6] An attribute of diversion indication for denoting that in the event of diversion, there is at least a p% probability that there will be a signal in the information (i.e., an abnormal situation) pinpointing the areas wherein removal occurred and highlighting the personnel having access to the SNM. Also, the specification of the area and personnel.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ASSOC/D, OPERATIONS
A/D, INSPECTION & ENFORCEMENT
A/D, FUEL CYCLE
A/D, SAFETY & MTL'S PROTECTION STDS.
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FIELD OFFICE MANAGER
LOCAL FBI OR LAW ENFORCEMENT

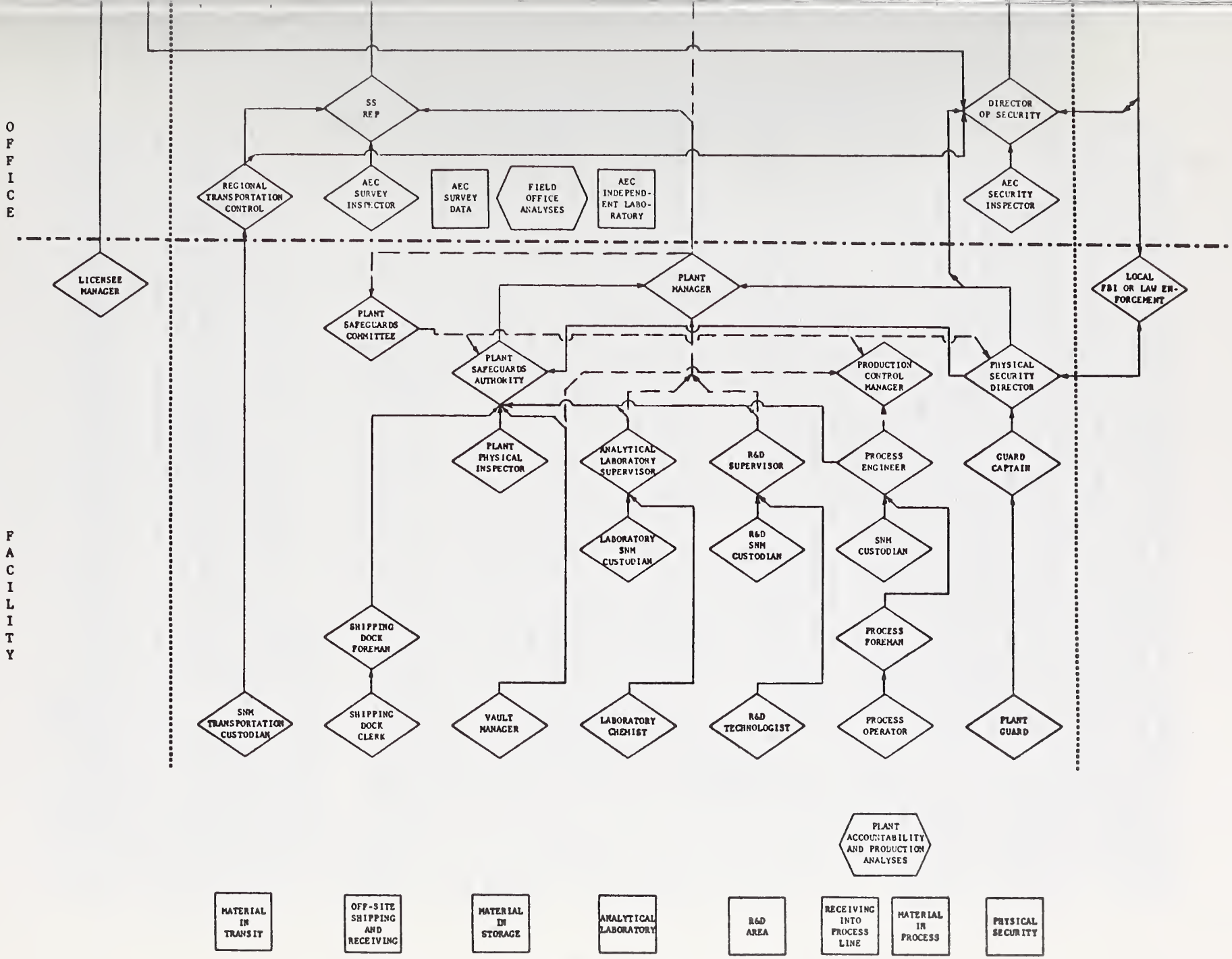

Figure 6 Abnormal Situation Reporting Flows

It must be remembered, however, that "ET_n" is a function of "n", and must therefore be re-evaluated each time "n" is incremented. In general, "ET_n" will decrease as "n" increases.

The elapsed time clock is interrogated at the three decision points (refer to Figure 5) designated "Elapsed Time Check". The interrogation indicated at level "n+2" is included to imply two-level reporting (that is the cognizant person at level "n+2" has a responsibility to see that action is taken at level "n+1" within the specified elapsed time). Once the allowed time has elapsed, the next level of assistance and responsibility must be called upon as a matter of routine. This concept removes from negotiation the decision as to whether or not to call for help since it insures that additional resources will be brought in to resolve abnormal situations when necessary.

Since each abnormal situation implies the possibility of diversion, time is of the essence: there must be no unnecessary delay in sounding an alarm when an alarm is warranted. With a fixed time schedule for alerting the next higher echelon, no judgment in regard to elapsed time need be exercised by the decision maker. The concept prevents adoption of a "wait and see" attitutde, and further insures that abnormal situations likely due to diversion will be identified in a timely manner as not being due to innocent cause.

The abnormal situation log, with the requirement for noting times, will help to determine whether the elapsed time requirement is being adhered to and will, in turn, allow time-response assurance statements to be made. Thus, the elapsed time clock is perhaps the most important element of the concept for, by assuring that the time sensitivity of safeguards is met, it dictates the making of a timely response to possible diversion.

When the decision maker realizes that an abnormal situation exists, it is incumbent upon him to act. Choice of action is, in itself, a decision responsibility and is dependent upon the diversion path. Each decision maker is exposed to a number of diversion paths[7], depending upon the data source over which he has purview, and can often observe more than one abnormal situation for a specific path. Each of the abnormal situations is observed by means of an available element of information which enables him to recognize the situation and initiate his actions. The choice of the sensitive element of information which allows recognition of the abnormal situation results from application of the last concept, diversion path analysis.

3.3 Diversion Path Analysis

The key to safeguards at the plant level is recognition of the existence of the abnormal situation, one which prompts the question: "Has diversion occurred?" The recognition responsibility resides with one of the decision makers identified earlier who, when specified for a given plant area, must be provided with mechanisms to alert him to action based on available information and the possible ways material could be diverted from the area.

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7 The complete and detailed description of a modus operandi and rationale, devised as an independent method, for illicitly removing and concealing the removal of SNM.

For a decision maker to become quickly aware of a relevant abnormal situation and its potential significance, his area of responsibility must be analyzed in advance and diversion paths made known. In the scope of SIS, such analyses would be performed by the plant safeguards authority (or a member of his staff), assisted by the process engineer[8] and process foreman of the area under scrutiny, subject to review by the AEC Field Office. The procedure for directing the systematic analysis is termed diversion path analysis (DPA). Details of the steps used in applying the procedure are given elsewhere [2]; in brief all conceivable diversion possibilities are identified and classified in descending order of seriousness and likelihood of occurrence. Information elements and safeguards activities are matched to possible diversions and the information used in the design of SIS is generated in order to satisfy the safeguards objectives. Concomitantly, consideration is also given to innocent explanations of seemingly alarming situations so that the decision maker has an informed basis for his actions.

The DPA concept is vital in safeguards. The cognizant authority at each level must be confident that, insofar as possible, all diversion paths have been examined, that these paths have been systematically ordered or ranked by establishable criteria; and that attention is focused on the more probable paths, at the same time reducing or eliminating further consideration of less probable ones. Once diversion paths have been traced, the data elements and their respective sources (either currently available or readily made available) are identified. These data elements are used to derive a set of variables, which are in turn analyzed either numerically or comparatively as diversion indicators. Identification of data elements relative to the most probable paths, individually considered, and performance of associated data analyses permit the cognizant decision maker to conclude at a high level of confidence whether or not diversion has occurred. His assurance may be expressed in the form of statements which provide information about the probability that verification, accounting and the adopted procedures accurately reflect the current status and operation of the safeguards system.

4. DECISION RESPONSIBILITIES OF THE PLANT SAFEGUARDS AUTHORITY

Having conceptualized the general types of information which decision makers need to carry out their safeguards activities, specific responsibilities and activities of the plant safeguards authority must be examined in detail in order to prescribe the information he requires.

The title "plant safeguards authority" is generic and was established during the evolution of SIS. The safeguards tasks and activities assigned to the plant safeguards authority have been laid down in accord with the overall SIS structure and serve as a guide which, when applied, will assure that all tasks and activities are performed and that the content of the information flows is complete.

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[8] The process engineer is the professional (or professionals) directly responsible for improvements to the process and for the specification of the internal and process controls to be used in the process area.

At some facilities another designator may be used (for example, Nuclear Materials Control), or the safeguards tasks and activities here prescribed may be performed by more than one person. Thus, for a specific plant, safeguards tasks, activities and responsibilities must be examined in light of this guide in order to pinpoint the individual most nearly matching this decision maker. If the tasks actually performed by the identified individual are not those prescribed by SIS, a careful review is in order. Consideration might be given to plant task reassignments as a means of better approximating SIS. If this is infeasible for administrative or other reasons, great care must be exercised in the design of the plant SIS in order to insure that all safeguard tasks, activities and responsibilities set-forth in the general SIS are assigned to specific decision makers and that the associated information flows accurately reflect these assignments.

4.1 Tasks and Safeguards Activities

The plant safeguards authority has first-line responsibility for decisions pertaining to safeguards system design, modification and operation. With assistance from process engineers and process foremen of the unit processes or MBA's under scrutiny, he conducts the diversion path analysis [2]. For each process area under analysis, he determines whether all pertinent path ordering parameters are considered, that all paths having a relative path weight greater than boundary conditions set forth in corporate or AEC guidelines are exhaustively analyzed, and that each analysis is properly documented. He is responsible for decisions that time factors associated with the elapsed time clock (Section 3.2) are realistic and sufficient, and that diversion path documentation accurately reflects the diversion paths, abnormal situations to be observed, possible innocent causes, information needs and responses of the observer, and cognizant persons to be notified in event of an abnormal situation. He verifies that internal control procedures incorporate observation for and reporting of abnormal situations highlighted as diversion indicators.

Irregular event procedures dictate, upon notification by the plant guard captain, that the plant safeguards authority initiate appropriate safeguards actions such as special inventory of the area involved, call for computer preparation of current inventory lists for unit processes and MBA's in the area, etc.

When notified by the production control manager that a portion of the process is under revision, the plant safeguards authority conducts the review and up-dates the diversion path analyses relating to the affected unit processes to insure that the analyses include any new diversion paths which result from the change and to delete old paths which are no longer applicable.

He is responsible for design of sampling plans on which are based the computer generated random lists for use by the plant physical inspector[9];

[9] The plant physical inspector performs random inspections of the facility, within the plant perimeter, directed specifically towards safeguards rather than physical security. Included are spot-checks for item presence using a list of items which is randomly generated from the general inventory file maintained in the plant data processing system and observations (on a random and unannounced basis) for lapses in procedures.

for initiating the establishment and improvement of measurement programs which are aimed at reducing uncertainty of measurements and uncertainty of MUF, particularly if such programs are not specifically required for production control; and the development of experimental procedures which verify measurement and MUF uncertainty calculations, indicator sensitivity and overall system operation. Each of these tasks and responsibilities lead to decisions that the overall system is properly designed or that necessary modifications are expeditiously accomplished.

Further responsibilities include design of the plant materials accounting and other internal control procedures. Since data elements collected for accounting and control (even though later aggregated for reporting purposes) are often analogous to those needed for safeguards, the plant safeguards authority is responsible for decisions that accounting and control information and data accurately reflect material and information flows within the plant. He also assures that duplication of data taken for each purpose (safeguards, accounting or internal control) be minimized through careful design of all systems.

He is responsible for the daily operation of the system and for decisions related to system operation which include evaluation of MUF and the uncertainty of MUF, resolution of shipper-receiver differences (S-R's) between plant MBA's and the plant and other facilities, physical inventory verification through activities of the plant physical inspector (general inventory activities are performed by production control), and audit, review and verification of all facets of safeguards procedures associated with plant MBA's.

The plant safeguards authority is the focal point for safeguards interactions between the production side of the plant, through the process engineers, and the quality control laboratories with reference to calibration and measurement control programs. He is also responsible for safeguards interaction, through the plant manager, with the cognizant AEC Field Office SS Rep and is the principal contact within the plant during AEC Field Office Survey inspections.

4.2 Information Needs

In order to carry out his responsibilities for system design, modification, and operation, and reach meaningful decisions, the plant safeguards authority requires the following information:

- facility-wide SNM accounting records;
- results of physical inventories;
- current and historical facility MUF data;
- narrative explanations of historical MUF;
- current and historical S-R data (inter- and intra-plant);
- calibration program measurement data;
- data on uncertainty of measurements;
- production control data;
- changes in production operations within unit processes;
- full particulars of irregular events such as fires, demonstrations or natural disasters; and
- overall knowledge of attractiveness, form and quantity of SNM in MBA's and unit processes.

5. DETAILED INFORMATION FLOWS FOR THE PLANT SAFEGUARDS AUTHORITY

The detailed information flows associated with the plant safeguards authority within the SIS structure, are defined once the interacting nodes and flows are identified, the interrelationships set forth, and the node content and flow content listed. This is not meant to imply, however, that once defined, the structure cannot or should not be changed. The concept of SIS, when correctly applied, permits modification of those portions of the structure subject to change because of new objectives or needs without requiring overhaul of the entire SIS. The caveat given above regarding review of safeguards tasks, activities and responsibilities of personnel in a specific plant, must, none the less, be observed.

Details of the information content and flow associated with the plant safeguards authority will be presented in terms of the SIS structure rather than in terms of an actual operating system. In actual practice, a plant's SIS document must be specific. For example, it might state in relation to an abnormal situation observed by a process foreman, A, in an MBA Q3: "Upon observing abnormal situation S_n, A will: (1) notify B (his process engineer) by telephone within M minutes; (2) complete abnormal situation reporting form F (shown in exhibit E); (3) file the original of the form in the abnormal situation log L, kept in MBA Q3 at a designated location; and (4) forward copy 1 of the form to B and copy 2 to C (the plant safeguards authority) within H hours." Further, the plant SIS document would list all abnormal situations, S_n, for the given unit process or MBA, state explicitly the allowable elapsed times, M and H, associated with each situation or class of situations, and give names, job titles, phone numbers and plant addresses of the individuals, B and C, referred to in the statement. In contrast, the general description for the plant safeguards authority which follows will indicate simply "abnormal situation information will be transmitted from X to Y" and will indicate generically who the decision makers are. Emphasis is placed on the flows, methods of flow, forms and documents to be used (in general terms), and the general distribution paths for the documents and forms. AEC forms are referenced by number, but forms and documents likely to be plant specific are described only in general terms.

The information flows associated with each of the nodes of SIS are addressed in detail in the comprehensive report [1]. It is useful, at this point, to introduce some of these details, summarized in the form of several lists, in order to further pinpoint the plant safeguards authority within the general framework. The nodes of SIS, subdivided by location, decision maker, data generating activities and information generating activities are listed in Table 2. The flows are listed in Table 3 as a function of end-point node, including flows for reporting purposes between decision makers and flows to information and analysis systems. The content of the SIS information flows is listed, in general terms, in Table 4.

Most of the flows listed in Table 3 are bi-directional, that is, information is transmitted from either end-point node to the other. Content of the flow, however, usually depends on the direction of flow. For example, the process engineer forwards to the plant safeguards authority

I. LOCATIONS
- A. Top echelon of Government
  - 1. Office of the President
  - 2. Office of the Joint Committee on Atomic Energy
- B. AEC Headquarters
- C. International Atomic Energy Agency
- D. Computer Sciences Division, NMIS Department, Oak Ridge
- E. AEC Field Offices
- F. Law enforcement units
  - 1. Local police
  - 2. Federal Bureau of Investigation Field Offices
  - 3. Federal Bureau of Investigation Headquarters
- G. Transportation elements
  - 1. Regional Transportation Control Centers
  - 2. Transportation units enroute
- H. Independent AEC laboratories
- I. Plants
  - 1. Processing areas
  - 2. R&D areas
  - 3. Analytical laboratories
  - 4. Storage areas
  - 5. Shipping and receiving areas
  - 6. Nuclear materials control unit
  - 7. Corporate internal audit unit
  - 8. Physical security
  - 9. Central data processing
  - 10. Management

II. DECISION MAKERS
- A. Management (reporting channels)
  - 1. The President
  - 2. The Joint Committee on Atomic Energy (JCAE)
  - 3. Atomic Energy Commission, Headquarters
    - a. Commissioners
    - b. General Manager (GM)
    - c. Assistant General Manager for National Security (AGMNS)
    - d. Director of Regulation
    - e. Director, Division of Safeguards and Security (DSS)
    - f. Assistant Director for Inspection and Appraisal (A/D I&A), DSS
    - g. Chief, Inspection and Appraisal Branch (I&A Branch), DSS
    - h. Chief, Internal Security Branch (IS Branch), DSS
    - i. AEC Appraiser
  - 4. Atomic Energy Commission, Field Offices
    - a. Manager
    - b. Source and Special Materials Representative (SS Rep)
    - c. Director of Security
    - d. AEC Survey Inspector
    - e. AEC Security Inspector
  - 5. Regional Transportation Control
  - 6. Plants
    - a. Manager

Table 2 The Nodes of SIS

b. Plant Safeguards Authority
c. Physical Security Director

B. Management (administrative channels)
1. Director, Federal Bureau of Investigation
2. Atomic Energy Commission, Headquarters
a. Directors, program divisions
b. Directors, staff divisions
3. Plants
a. Safeguards Committee
b. Production Control Manager

C. Investigative Forces
1. Agents, Federal Bureau of Investigation, Headquarters
2. Agents, Federal Bureau of Investigation, Field Offices

D. Transportation
1. SNM Transportation Custodian, Driver
2. SNM Transportation Custodian, Courier

E. Plant
1. Physical Security
a. Guard Captain
b. Guard
2. R&D Area
a. Supervisor
b. SNM Custodian
c. Technologist
3. Analytical Laboratory
a. Supervisor
b. SNM Custodian
c. Chemist
4. Shipping and Receiving
a. Shipping Dock Foreman
b. Shipping Dock Clerk
5. Storage
a. SNM Custodian (MBA)
b. Plant Physical Inspector
c. Vault Manager
6. Process Line
a. Process Engineer (Unit Process or MBA)
b. SNM Custodian (MBA)
c. Process Foreman (MBA or Several Unit Processes)
d. Process Operator (Unit Process)

III. DATA GENERATING ACTIVITIES

A. Material Transfer Activities
1. Receiving
a. Observations
1) Material from Off-site
2) Internal Transfers
b. Measurements
1) Material from Off-site
2) Internal Transfers

Table 2 (continued) The Nodes of SIS

2. Shipping
   a. Observations
      1) Material going Off-site
      2) Internal Transfers
   b. Measurements
      1) Material going Off-site
      2) Internal Transfers

B. Material Processing Activities
   1. Batch Make-up
   2. Sampling
   3. Changing of Form
      a. Physical
      b. Chemical
      c. Isotopic
   4. Control Measurements
      a. Process
      b. Quality

C. Internal Control Activities
   1. Health and Safety
      a. Measurements
      b. Monitoring
   2. Physical Security Observations
   3. Diversion Path Analyses
   4. Abnormal Situation Activities
   5. Internal Audit

D. Material Balance Accounting Activities
   1. Striking the Balance
   2. Inventory Taking
   3. Composition of Ending Inventory (COEI)
   4. Inventory Verification

E. Analytical Laboratory Measurements

F. R&D Area Measurements

G. Scheduling Activities
   1. Preparation of Work Orders by Process Engineer
   2. Scheduling Work Orders
      a. Analytical Laboratory Supervisor
      b. R&D Area Supervisor
   3. Preparation of Plant Schedules by Production Control Manager

H. Plant Safeguards Committee Recommendations

I. Plant Safeguards Authority Reports To:
   1. Plant Manager
   2. AEC Field Office

J. AEC Survey Activities
   1. Sampling and Independent Measurements
   2. Independent Inventory Verification Observations
   3. Other Observations

K. AEC Appraisal Activities

IV. INFORMATION GENERATING ACTIVITIES

A. Data Processing Activities

Table 2 (continued) The Nodes of SIS

1. Plant Process Areas
2. Plant Central Data Processing Facility
3. Plant Accounting Activities
4. Computer Sciences Division, NMIS Department, Oak Ridge
5. AEC Headquarters

B. Diversion Path Analyses

C. Reaching Conclusions Based On:
1. Abnormal Situation Information Assessment
2. Evaluation of Process Data Obtained from all Data Processing Activities (IV.A.)
3. AEC Survey Evaluations
   a. General
   b. Material Balance Accounting
      1) Measurement Systems
      2) Record Systems
      3) Book Inventory
      4) Physical Inventory
      5) Measurement Control Program
      6) Uncertainties in Measurements
      7) Calculation of Uncertainty in MUF
      8) MUF Analysis and Evaluation
   c. Systematic Analytical Alerting and Assurance Procedures
      1) Review of Procedures
      2) Review of Diversion Path Analyses
      3) Review for Completeness
      4) Review of Abnormal Situation Logs
      5) Evaluation of Procedures
   d. Review of Abnormal Situations Observable by AEC Survey Inspector
4. AEC Appraisal Evaluations
   a. General
   b. Personnel
      1) Capability
      2) Performance
   c. Field Office Survey Activities
      1) On-site Reviews
      2) Work Papers
      3) Resulting Assurance Statements

D. Generation of Assurance Statements
1. Within Plant
   a. Process Areas
      1) Process Operator to Process Foreman
      2) Process Foreman to Process Engineer
      3) MBA SNM Custodian to Process Engineer
      4) Process Engineer to Plant Safeguards Authority
   b. Physical Security
      1) Plant Guard to Plant Guard Captain
      2) Plant Guard Captain to Physical Security Director
      3) Physical Security Director to Plant Safeguards Authority

Table 2 (continued) The Nodes of SIS

c. R&D Areas
   1) R&D Technologist to R&D Supervisor
   2) R&D SNM Custodian to R&D Supervisor
   3) R&D Supervisor to Plant Safeguards Authority
d. Analytical Laboratory
   1) Laboratory Chemist to Laboratory Supervisor
   2) Laboratory SNM Custodian to Laboratory Supervisor
   3) Laboratory Supervisor to Plant Safeguards Authority
e. Storage Areas
   1) Vault Manager to Plant Safeguards Authority
   2) Plant Physical Inspector to Plant Safeguards Authority
f. Off-site Shipping and Receiving
   1) Shipping Dock Clerk to Shipping Dock Foreman
   2) Shipping Dock Foreman to Plant Safeguards Authority
g. Management
   1) Plant Safeguards Authority to Plant Manager
   2) Physical Security Director to Plant Manager
   3) Plant Safeguards Committee to Plant Manager

2. Transportation
   a. SNM Transportation Custodian to Regional Transportation Control
3. Between Plant and Field Office
   a. Plant Manager to SS Rep
   b. Plant Manager to Field Office Manager
   c. Physical Security Director to Director of Security
4. Within Field Office
   a. AEC Survey Inspector to SS Rep
   b. Regional Transportation Control to SS Rep
   c. Regional Transportation Control to Director of Security
   d. SS Rep to Field Office Manager
   e. AEC Security Inspector to Director of Security
   f. Director of Security to Field Office Manager
5. Between Field Office and AEC Headquarters
   a. Field Office Manager to Director, DSS
   b. Director of Security to Chief, IS Branch, DSS
   c. Director of Security to Director, DSS
6. AEC Headquarters and Top Echelon of Government
   a. AEC Appraiser to Chief, I&A Branch, DSS
   b. Chief, I&A Branch, DSS, to A/D, I&A, DSS
   c. Chief, IS Branch, DSS, to Director, DSS
   d. A/D, I&A, DSS, to Director, DSS
   e. Director, DSS, to AGMNS
   f. AGMNS to GM
   g. GM to AEC Commissioners
   h. GM to JCAE
   i. AEC Commissioners to JCAE
   j. AEC Commissioners to the President
   k. The President to the Public

Table 2 (continued) The Nodes of SIS

BIDIRECTIONAL REPORTING FLOWS OF INFORMATION

R-001 President - AEC Commissioners
R-002 JCAE - AEC Commissioners
R-003 JCAE - GM
R-004 AEC Commissioners - GM
R-005 AEC Commissioners - Director of Regulation[1]

R-006 GM - AGMNS
R-007 AGMNS - Director, DSS
R-008 Director, DSS - A/D, I&A, DSS
R-009 Director, DSS - Chief, I&A Branch, DSS
R-010 Director, DSS - Field Office Manager

R-011 Director, DSS - SS Rep
R-012 Director, DSS - FBI Headquarters
R-013 Director, DSS - Field Office Director of Security
R-014 Director, DSS - Chief, IS Branch, DSS
R-015 A/D, I&A, DSS - Chief, I&A Branch, DSS

R-016 Chief, I&A Branch, DSS - AEC Appraiser
R-017 Chief, IS Branch, DSS - FBI Headquarters
R-018 Chief, IS Branch, DSS - AEC Appraiser
R-019 Chief, IS Branch, DSS - Field Office Director of Security
R-020 AEC Appraiser - SS Rep

R-021 AEC Appraiser - Field Office Director of Security
R-022 Field Office Manager - SS Rep
R-023 Field Office Manager - Field Office Director of Security
R-024 Field Office Manager - Plant Manager
R-025 SS Rep - Regional Transportation Control

R-026 SS Rep - AEC Survey Inspector
R-027 SS Rep - Plant Manager
R-028 SS Rep - Plant Safeguards Authority
R-029 Field Office Director of Security - Local FBI
R-030 Field Office Director of Security - Local Law Enforcement

R-031 Field Office Director of Security - SS Rep
R-032 Field Office Director of Security - Regional Transportation Control
R-033 Field Office Director of Security - AEC Security Inspector
R-034 Field Office Director of Security - Plant Manager
R-035 Field Office Director of Security - Physical Security Director

R-036 AEC Survey Inspector - Plant Manager
R-037 AEC Survey Inspector - Plant Safeguards Authority
R-038 AEC Survey Inspector - AEC Independent Laboraotry
R-039 AEC Security Inspector - Plant Manager
R-040 AEC Security Inspector - Physical Security Director

Table 3 SIS Information Flows as a Function of End-Point Node

BIDIRECTIONAL REPORTING FLOWS OF INFORMATION (continued)

R-041 Regional Transportation Control - SNM Transportation Custodian
R-042 Plant Manager - Plant Safeguards Committee
R-043 Plant Manager - Plant Safeguards Authority
R-044 Plant Manager - Production Control Manager
R-045 Plant Manager - Physical Security Director

R-046 Plant Safeguards Committee - Plant Safeguards Authority
R-047 Plant Safeguards Committee - Production Control Manager
R-048 Plant Safeguards Committee - Physical Security Director
R-049 Plant Safeguards Authority - Plant Safeguards Authority (other facility)
R-050 Plant Safeguards Authority - Production Control Manager

R-051 Plant Safeguards Authority - Physical Security Director
R-052 Plant Safeguards Authority - Process Engineer
R-053 Plant Safeguards Authority - R&D Supervisor
R-054 Plant Safeguards Authority - Analytical Laboratory Supervisor
R-055 Plant Safeguards Authority - Plant Physical Inspector

R-056 Plant Safeguards Authority - Plant Guard Captain
R-057 Plant Safeguards Authority - MBA SNM Custodian
R-058 Plant Safeguards Authority - R&D SNM Custodian
R-059 Plant Safeguards Authority - Laboratory SNM Custodian
R-060 Plant Safeguards Authority - Process Foreman

R-061 Plant Safeguards Authority - Shipping Dock Foreman
R-062 Plant Safeguards Authority - Vault Manager
R-063 Production Control Manager - AEC Survey Inspector
R-064 Production Control Manager - Process Engineer
R-065 Production Control Manager - MBA SNM Custodian

R-066 Production Control Manager - Vault Manager
R-067 Physical Security Director - AEC Security Inspector
R-068 Physical Security Director - Plant Guard Captain
R-069 Physical Security Director - Plant Guard
R-070 Physical Security Director - Local FBI

R-071 Physical Security Director - Local Law Enforcement
R-072 Process Engineer - AEC Survey Inspector
R-073 Process Engineer - Process Engineer (another MBA)
R-074 Process Engineer - R&D Supervisor
R-075 Process Engineer - Analytical Laboratory Supervisor

R-076 Process Engineer - MBA SNM Custodian
R-077 Process Engineer - Process Foreman
R-078 Process Engineer - Process Operator
R-079 Process Foreman - AEC Survey Inspector
R-080 Process Foreman - MBA SNM Custodian

Table 3 (continued) SIS Information Flows as a Function of End-Point Node

BIDIRECTIONAL REPORTING FLOWS OF INFORMATION (continued)

R-081 Process Foreman - Process Foreman (adjacent process of MBA)
R-082 Process Foreman - Process Operator
R-083 Process Operator - Plant Safeguards Authority
R-084 Process Operator - MBA SNM Custodian
R-085 Process Operator - Process Operator (same or adjacent unit process)

R-086 R&D Supervisor - R&D SNM Custodian
R-087 R&D Supervisor - R&D Technologist
R-088 R&D SNM Custodian - R&D Technologist
R-089 R&D Technologist - Plant Safeguards Authority
R-090 Analytical Laboratory Supervisor - Laboratory SNM Custodian

R-091 Analytical Laboratory Supervisor - Laboratory Chemist
R-092 Laboratory SNM Custodian - Laboratory Chemist
R-093 Laboratory Chemist - Plant Safeguards Authority
R-094 MBA SNM Custodian - AEC Survey Inspector
R-095 R&D SNM Custodian - AEC Survey Inspector

R-096 Laboratory SNM Custodian - AEC Survey Inspector
R-097 MBA SNM Custodian - MBA SNM Custodian (adjacent MBA)
R-098 MBA SNM Custodian - R&D SNM Custodian
R-099 MBA SNM Custodian - Laboratory SNM Custodian
R-100 R&D SNM Custodian - R&D SNM Custodian (another R&D area)

R-101 Laboratory SNM Custodian - Laboratory SNM Custodian (another laboratory)
R-102 Plant Physical Inspector - AEC Survey Inspector
R-103 Plant Physical Inspector - Plant Manager
R-104 Plant Physical Inspector - MBA SNM Custodian
R-105 Plant Physical Inspector - R&D SNM Custodian

R-106 Plant Physical Inspector - Laboratory SNM Custodian
R-107 Plant Physical Inspector - Vault Manager
R-108 Vault Manager - AEC Survey Inspector
R-109 Vault Manager - Process Engineer
R-110 Vault Manager - MBA SNM Custodian

R-111 Vault Manager - R&D SNM Custodian
R-112 Vault Manager - Laboratory SNM Custodian
R-113 Vault Manager - Process Operator
R-114 Vault Manager - R&D Technologist
R-115 Vault Manager - Laboratory Chemist

R-116 Vault Manager - Plant Guard
R-117 Shipping Dock Foreman - AEC Survey Inspector
R-118 Shipping Dock Foreman - Regional Transportation Control
R-119 Shipping Dock Foreman - Plant Manager
R-120 Shipping Dock Foreman - Vault Manager

Table 3 (continued) SIS Information Flows as a Function of End-Point Node

BIDIRECTIONAL REPORTING FLOWS OF INFORMATION (continued)

R-121 Shipping Dock Foreman - Shipping Dock Clerk
R-122 Shipping Dock Clerk - Plant Safeguards Authority
R-123 Shipping Dock Clerk - MBA SNM Custodian
R-124 Shipping Dock Clerk - R&D SNM Custodian
R-125 Shipping Dock Clerk - Laboratory SNM Custodian

R-126 Shipping Dock Clerk - Process Operator
R-127 Shipping Dock Clerk - Shipping Dock Clerk (another facility)
R-128 Plant Guard Captain - AEC Security Inspector
R-129 Plant Guard Captain - Plant Manager
R-130 Plant Guard Captain - Plant Guard

R-131 Plant Guard - Plant Safeguards Authority
R-132 Plant Guard - Shipping Dock Foreman
R-133 Plant Guard - Plant Guard
R-134 SNM Transportation Custodian - SS Rep
R-135 SNM Transportation Custodian - Shipping Dock Clerk

BIDIRECTIONAL INFORMATION FLOWS TO INFORMATION AND ANALYSIS SYSTEMS

S-001 NMIS - Director, DSS
S-002 NMIS - AEC Appraiser
S-003 NMIS - AEC Survey Inspector
S-004 NMIS - SS Rep
S-005 NMIS - Plant Safeguards Authority

S-006 NMIS - Plant Data Processing System (PDPS)[2]
S-007 PDPS - AEC Survey Inspector
S-008 PDPS - Plant Manager
S-009 PDPS - Plant Safeguards Authority
S-010 PDPS - Process Engineer

S-011 PDPS - SNM Custodian (MBA, R&D or Laboratory)
S-012 PDPS - Process Foreman
S-013 PDPS - Process Operator
S-014 PDPS - Shipping Dock Foreman
S-015 PDPS - Shipping Dock Clerk

S-016 PDPS - Plant Physical Inspector
S-017 PDPS - Vault Manager

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[1] Safeguards activities of Director of Regulation beyond scope of study. Information flows associated with Licensees are excluded from list.

[2] PDPS comprised of plant safeguards data base and related materials accounting and data monitoring activities. It may be located centrally or be dispersed throughout the plant and can be computerized or manual.

Table 3 (continued) SIS Information Flows as a Function of End-Point Node

I. ABNORMAL SITUATION INFORMATION
   A. Discovery
      1. How much
      2. From where
      3. Kind of material
      4. First observation
      5. Time window for occurrence
      6. How indicated
      7. Possible innocent causes of indication
      8. Who made first report
      9. Personnel possibly involved
   B. Investigation
      1. Past actions taken
      2. Current actions
      3. Future actions to be taken
      4. Correlative and corroborant information
         a. Within node discovering abnormal situation
         b. Outside of node discovering abnormal situation
II. MATERIAL ACCOUNTING INFORMATION
   A. Transfer information
   B. Inventory information
   C. Inventory change information
      1. Production
      2. Accidental loss
      3. Decay
      4. Burn-up
      5. Measured discard
   D. Material balance accounting information
      1. MUF
      2. Components of MUF equation
      3. Known, localized contributors to MUF
      4. Uncertainty of MUF
      5. Principal contributors to uncertainty of MUF
      6. Prior period adjustments
III. DIVERSION PATH ANALYSIS INFORMATION
IV. SURVEY INSPECTION AND APPRAISAL INFORMATION
V. ASSURANCE INFORMATION AND ASSURANCE STATEMENTS
VI. MANAGEMENT INFORMATION
   A. Safeguards policy
   B. Other administrative directives related to safeguards
VII. TECHNICAL INFORMATION
   A. Measurements performed
      1. Chemical
      2. Physical
      3. Non-destructive
   B. Calibration techniques
   C. Standards
   D. Evaluation of measurements
   E. Evaluation techniques
   F. Analysis techniques
VIII. INFORMATION IN RESPONSE TO SPECIAL SAFEGUARDS RELATED REQUESTS

Table 4 Content of SIS Information Flows

information and reports on abnormal situations, analytical surveillance exception reports, notification of changes in process operations which necessitate review of diversion path analyses, safeguards system design and modification information and suggestions, diversion path analysis data and information, general observations about process operations and notification of safeguards related problems. On the other hand, the plant safeguards authority returns to the process engineer the results of diversion path analyses for his area, innocent cause, resolution or other feedback information about reported abnormal situations, allowable elapsed times for reporting abnormal situations, solutions to safeguards problems and safeguards policy.

The following procedure is used for characterizing a node in detail. Keeping in mind the specific information needs derived from safeguards tasks, activities and responsibilities incumbent on the node, review is made of information and data generating activities within the node (description of the node), and of the documentation concerning node activities which is prepared and/or maintained in the node (content of the node). The identities of other nodes with which this node interacts are derived through examination of the description and content of this node and of each of the other nodes, at all levels in the SIS structure (see Figure 2), in order to determine the available sources for the information needed by this node and, in light of the information needs of other nodes, in order to specify the information which this node is capable of furnishing. Such examination reveals the information and data to be transmitted (content of flows) from and to the identified nodes and divides reporting from administrative flows (purpose of flow). Whether the flow is oral or written (method of flow) is also revealed and is contingent upon both the content of flow and the identity of the interacting node. The method of flow is also governed, in part, by some basic premises, applied system-wide, regarding certain contents of flow. For example, the notification of abnormal situation alerts and alarms should be made quickly, whereas the supporting reports (which might be used for investigative actions or at the time of system review) should be prepared within some specified time while events are still fresh in the mind. Thus, this premise dictates an oral flow (probably by telephone) in the case of alerts and alarms and a written flow (because of the intended end-use) in the case of the supporting report. Another premise relates to the supporting report as prepared by nodes at lower levels of the SIS structure (e.g., a process operator). The report is required to be brief, giving only pertinent facts (date, time and location of discovery, identification of discoverer, nature of the event, SNM type and estimated quantity involved, and initial actions taken). Brevity is dictated in order to reduce cumbersome report preparation which might deter filing and, further, to minimize reporting costs in cases of innocent cause.

The procedure is applied in an iterative manner starting with a node at the lowest level in the decision structure. In the development of SIS the process operator node was the first to be characterized: his operational duties bring him into contact with SNM which makes him a first-hand observer of abnormal situations, the data and information which he receives and sends is well established, and his information needs (derived prior to undertaking

the detailed characterization) and safeguards tasks, activities and responsibilities are not complex. (Such a decision maker would serve well as the starting point for design a plant SIS.)

When the process operator node was first reviewed, attention was given to the information and data received, tempered by information needs, noting the sources. The data which results from operational activities was noted together with the records and logs he maintains and the forms and reports which he prepares. Further note was made of each decision maker to whom he sends forms and reports and those who review his records and logs; such decision makers would normally be prescribed in operating and/or internal control procedures. All of this information was recorded in a suitable format (an example of which is shown later with reference to the plant safeguards authority) and a schematic drawing was prepared to indicate the identified details. The detailed characterization of the node at the next higher level in the SIS structure (process foreman) was then begun, building on the characterization of the process operator. The procedure was repeated until the detailed characterization of each node was accomplished.

As one characterizes nodes at higher levels in the structure, the complexity of the contents of the nodes and contents of the flows increases. Particularly for higher level nodes, the schematic drawing of completed nodes becomes important. The identity of interacting nodes at lower levels, as well as the content of the information flows from these nodes, are readily apparent through study of the diagrams. Thus, comparison of the diagrams assures completeness and reduces the possibility of missing any flows. Further, as one characterizes nodes at higher levels in the structure, it may be found that an information flow to a lower level node was not recognized earlier or that the content of a flow was incorrectly or, more generally, incompletely perceived. The schematic provides a means for quickly detecting the error. Discovery of such errors necessitates an iteration through all completed characterizations in order to up-date the written narratives and schematic drawings of affected nodes.

By carrying the procedure to completion, one is assured that all elements listed in Tables 2, 3 and 4 are addressed, that all interacting nodes are accounted for, and that the content of the information flowing through the system leads to satisfaction of safeguards goals.

With this background on procedure in mind, the detailed characterization the plant safeguards authority node can now be stated. It is presented in the format used in the comprehensive report [1] for each node of SIS: the general node description (location and decision maker); summary of the information needs (as derived in Section 4 above); and the characterization of the node in terms of (1) incoming information flows, (2) information and data generated, (3) records maintained, (4) records and reports prepared, and (5) outgoing information flows.

The general node description and summary of information needs are repetitious, but are restated here in order to bring together all pertinent information about the node. The characterization is given in outline form in order to present the details as concisely as possible. Study of the outline reveals the nodes with which the plant safeguards authority interacts and the content of the information flows received from and sent to these nodes. The content of the plant safeguards authority node itself is also revealed.

The schematic drawing of the detailed characterization is shown in Figures 7 and 7a using the symbols from Figure 1. Symbols with solid borders represent characteristics directly associated with the plant safeguards authority, whereas dashed borders indicate interacting characteristics from adjacent nodes. Space limitations prevent complete annotation of the content of flows; numbered circles refer the reader to the similarly keyed listing appearing above Figure 7a (for annotations of the contents of flows to higher levels in the SIS structure) and also (for all interacting nodes) to similarly keyed section in the outline where the description of the contents of a particular flow is given. Decision makers who prepare reports flowing to the node are identified by means of small, labelled, dashed diamonds. The identity of the decision makers, thus labelled, is given in the list above and to the left of Figure 7a; upper case letters are used to designate groups of decision makers, each of whom sends information having the same general content as indicated, and lower case letters are used to designate individual decision makers.

By setting down the detailed description of SIS in the manner described, two aims are achieved. First, insurance is given that all pertinent information is transmitted along the flows indicated in Table 3, that all flow contents listed in Table 4 are considered, that the decision maker receives only the information he needs in order to reach his decisions and is not overburdened with extraneous information, and that a system of checks and balances is maintained between nodes, allowing decision makers to present meaningful assurance statements.

Second, it should be apparent that design of an information system to satisfy safeguards goals is rather laborious and time consuming. Thus, when design of a plant-specific SIS is undertaken, the bulk of the effort required of the designer has already been done for him and the benefits accruing from the first aim are automatically assured if the safeguards tasks, activities and responsibilities of plant personnel can be brought into line with those set-forth in the general SIS.

5.1 General Node Description

Location: PLANT
Decision Maker: PLANT SAFEGUARDS AUTHORITY

5.2 Summary of Information Needs

Facility-wide SNM accounting records
Results of physical inventories
Facility MUF and uncertainty of MUF data with description of sources
Narrative explanations of MUF
Current and historical S-R data (inter- and intra-plant)
Calibration program measurement data
Data on uncertainty of measurements
Production control data
Changes in production operations within unit processes (periodic)
Full particulars of irregular events such as fires, demonstrations or natural disasters
Overall knowledge of attractiveness, form and quantity of SNM in MBA's and unit processes

5.3 Characterization of Node

Information flows associated with the node are illustrated schematically in Figures 7 and 7a, and pertinent details of the content of the node and content of the flows are given in the following outline.

I. INCOMING INFORMATION FLOWS TO THIS NODE
  A. From process foreman
(1) 1. Abnormal situation reports and/or copies of log entries
    a. If discoverer is sender (copy of log entry)
      1) Date and time of discovery
      2) Identification (man- or badge-number) of discoverer
      3) Statement of pertinent facts
        a) Material type
        b) Quantity
        c) Location
        d) Initial actions taken
(2) b. If discoverer is subordinate of sender (report)
      1) Date and time of notification
      2) Identification of process operator
      3) Unit process involved
      4) Actions taken for abnormal situation verification
      5) Date and time process engineer notified by process foreman if abnormal situation unresolved during allowed elapsed time
      6) Statement of resolution if abnormal situation cleared-up using information available to process foreman but not to process operator

a) Explanation of innocent cause, or
b) Description of operational error, or
c) Indicator of safeguards system design error

(3) 2. Diversion path analysis information

B. From MBA SNM custodian

(1) 1. Copies of abnormal situation log entries
a. Date and time of discovery
b. Identification (man- or badge-number) of discoverer
c. Brief statement of pertinent facts
1) Material type
2) Quantity
3) Location
4) Initial actions taken

C. From process engineer

(4) 1. Abnormal situation information and alerts
a. Discovery
b. Investigative
c. Innocent cause
d. Resolution

2. Abnormal situation reports and/or copies of log entries

(1) a. If discoverer is sender (copy of log entry)
1) Date and time of discovery
2) Identification (man- or badge-number) of discoverer
3) Complete statement of pertinent facts
a) Material type
b) Quantity
c) Location
d) Analytical surveillance indicator
e) Diversion path description
f) Initial actions taken

(2) b. If discoverer is subordinate of sender (report)
1) Date and time of notification
2) Identification of process operator, process foreman or MBA SNM custodian
3) Unit process or MBA involved
4) Actions taken for abnormal situation verification
5) Date and time plant safeguards authority notified by process engineer if abnormal situation unresolved during allowed elapsed time
6) Statement of resolution if abnormal situation cleared-up using information available to process engineer but not to discoverer
a) Explanation of innocent cause, or
b) Description of operational error, or
c) Indicator of safeguards system design error

3. Analytical surveillance exception reports

(5) 4. Changes in process operations or in production control rules, regulations and procedures which make diversion path analysis review necessary

(6) 5. Information from periodic review of safeguards aspects of plant-specific rules, regulations and procedures which govern unit process or MBA production activities

(7) 6. Other information
   a. Safeguards system design and modification information
   b. Diversion path analysis information
   c. Observations relating to MBA or unit process activities
   d. Notification of problems arising from MBA or unit process activities
   e. Assurance information

D. From R&D SNM custodian

(1) 1. Copies of abnormal situation log entries
   a. Date and time of discovery
   b. Identification (man- or badge-number) of discoverer
   c. Brief statement of pertinent facts
      1) Material type
      2) Quantity
      3) Location
      4) Initial actions taken

E. From R&D supervisor

(4) 1. Abnormal situation information and alerts
   a. Discovery
   b. Investigative
   c. Innocent cause
   d. Resolution

2. Abnormal situation reports and/or copies of log entries

(1) a. If discoverer is sender (copy of log entry)
      1) Date and time of discovery
      2) Identification (man- or badge-number) of discoverer
      3) Complete statement of pertinent facts
         a) Material type
         b) Quantity
         c) Location
         d) Diversion path description
         e) Initial actions taken

(2) b. If discoverer is subordinate of sender (report)
      1) Date and time of notification
      2) Identification of R&D technologist or R&D SNM custodian
      3) R&D area involved
      4) Actions taken for abnormal situation verification
      5) Date and time plant safeguards authority notified by R&D supervisor if abnormal situation unresolved during allowed elapsed time
      6) Statement of resolution if abnormal situation cleared-up using information available to R&D supervisor but not to discoverer
         a) Explanation of innocent cause, or
         b) Description of operational error, or
         c) Indicator of safeguards system design error

3. R&D results applicable to safeguards (if performed)
(6) 4. Information from periodic review of safeguards aspects of plant-specific rules, regulations and procedures which govern R&D area activities
(7) 5. Other information
   a. Safeguards system design and modification information
   b. Diversion path analysis information
   c. Observations relating to R&D area activities
   d. Notification of problems arising from R&D area activities
   e. Assurance information

F. From laboratory SNM custodian
(1) 1. Copies of abnormal situation log entries
   a. Date and time of discovery
   b. Identification (man- or badge-number) of discoverer
   c. Brief statement of pertinent facts
      1) Material type
      2) Quantity
      3) Location
      4) Initial actions taken

G. From analytical laboratory supervisor
(4) 1. Abnormal situation information and alerts
   a. Discovery
   b. Investigative
   c. Innocent cause
   d. Resolution
2. Abnormal situation reports and/or copies of log entries
(1) a. If discoverer is sender (copy of log entry)
      1) Date and time of discovery
      2) Identification (man- or badge-number) of discoverer
      3) Complete statement of pertinent facts
         a) Material type
         b) Quantity
         c) Location
         d) Diversion path description
         e) Initial actions taken
(2) b. If discoverer is subordinate of sender (report)
      1) Date and time of notification
      2) Identification of analytical chemist or laboratory SNM custodian
      3) Laboratory involved
      4) Actions taken for abnormal situation verification
      5) Date and time plant safeguards authority notified by analytical laboratory supervisor if abnormal situation unresolved during allowed elapsed time
      6) Statement of resolution if abnormal situation cleared-up using information available to analytical laboratory supervisor but not to discoverer
         a) Explanation of innocent cause, or
         b) Description of operational error, or
         c) Indicator of safeguards system design error

(8) 3. Calibration program data
   a. Measurements
   b. Uncertainties associated with various types of measurements
      1) Balances
      2) Analytical procedures
      3) Isotopic concentration determinations
      4) Non-destructive assay or test
      4) Sampling

(9) 4. Results of specially requested measurements

(6) 5. Information from periodic review of safeguards aspects of plant-specific rules, regulations and procedures which govern analytical laboratory activities

(7) 6. Other information
   a. Safeguards system design and modification information
   b. Diversion path analysis information
   c. Observations relating to analytical laboratory activities
   d. Notification of problems arising from analytical laboratory activities
   e. Assurance information

H. From vault manager

(4) 1. Abnormal situation information and alerts
   a. Discovery
   b. Investigative
   c. Innocent cause
   d. Resolution

(1) 2. Copies of abnormal situation log entries
   a. Date and time of discovery
   b. Identification (man- or badge-number) of discoverer
   c. Brief statement of pertinent facts
      1) Material type
      2) Quantity
      3) Location of vault
      4) Location in vault
      5) Initial actions taken

I. From plant physical inspector

(4) 1. Abnormal situation information and alerts
   a. Discovery
   b. Investigative
   c. Innocent cause
   d. Resolution

(1) 2. Copies of abnormal situation log entries
   a. Date and time of discovery
   b. Identification (man- or badge-number) of discoverer
   c. Brief statement of pertinent facts
      1) Material type
      2) Quantity
      3) Location
      4) Initial actions taken

3. Routine reports of observations and inspections
(10) 4. Other information
   a. Notification of problems arising from inspection activities
   b. Diversion path analysis information
   c. Assurance information

J. From shipping dock clerk
(4) 1. Copies of abnormal situation log entries
   a. Date and time of discovery
   b. Identification (man- or badge-number) of discoverer
   c. Brief statement of pertinent facts
      1) Material type
      2) Quantity
      3) Location
      4) Initial actions taken

K. From shipping dock foreman
(4) 1. Abnormal situation information and alerts
   a. Discovery
   b. Investigative
   c. Innocent cause
   d. Resolution
   2. Abnormal situation reports and/or copies of log entries
(1) a. If discoverer is sender (copy of log entry)
      1) Date and time of discovery
      2) Identification (man- or badge-number) of discoverer
      3) Brief statement of pertinent facts
         a) Material type
         b) Quantity
         c) Location
         d) Initial actions taken
(2) b. If discoverer is subordinate of sender (report)
      1) Date and time of notification
      2) Identification of shipping dock clerk
      3) Shipping dock area involved
      4) Actions taken for abnormal situation verification
      5) Date and time plant safeguards authority notified by shipping dock foreman if abnormal situation unresolved during allowed elapsed time
      6) Statement of resolution if abnormal situation cleared-up using information available to shipping dock foreman but not of shipping dock clerk
         a) Explanation of innocent cause, or
         b) Description of activity error, or
         c) Indicator of safeguards system design error
(11) 3. Shipping dock activity reports
   a. Items and/or containers received
   b. Items and/or containers transferred on-site
   c. Items and/or containers shipped
   4. Notification of receipts or shipments

5. Confirmation that regional transportation control has been notified of receipt or shipment

(7) 6. Other information
   a. Safeguards system design and modification suggestions
   b. Diversion path analysis information
   c. Observations relating to shipping dock activities
   d. Notification of problems arising in shipping dock area
   e. Assurance information

L. From plant guard captain

(1) 1. Abnormal situation reports and/or copies of log entries
   a. If discoverer is sender (copy of log entry)
      1) Date and time of discovery
      2) Identification (man- or badge-number) of discoverer
      3) Statement of pertinent facts
         a) Location
         b) Circumstances
         c) Initial actions taken

(2) b. If discoverer is subordinate of sender (report, administrative flow)
      1) Date and time of notification
      2) Identification of plant guard
      3) Area of facility or perimeter involved
      4) Actions taken for abnormal situation verification
      5) Date and time physical security director, plant safeguards authority and plant manager notified by plant guard captain if abnormal situation unresolved during allowed elapsed time
      6) Statement of resolution if abnormal situation cleared-up using information available to plant guard captain but not to plant guard
         a) Explanation of innocent cause, or
         b) Description of operational error, or
         c) Indicator of safeguards preventive system design error

(12) 2. Information from periodic review of abnormal situation log, prepared by plant guard captain, when verification is made that physical security system, as it applies to safeguards, is correctly designed and properly functioning

(13) 3. Other information
   a. Breach of physical security which poses a safeguards problem such as attempted or successful entry or exit of unauthorized personnel at controlled area or attempts to bring unauthorized material through doorway monitor or past gate guard
   b. Notification of irregular events
      1) Fires or accidents
      2) Demonstrations
      3) Natural disasters
   c. Information on material recovery

(14) M. From process operator, process foreman, MBA SNM custodian, process engineer, R&D technologist, R&D SNM custodian, R&D supervisor, laboratory chemist, laboratory SNM custodian, analytical laboratory supervisor, vault manager, plant physical inspector, shipping dock clerk, shipping dock foreman, plant guard and plant guard captain

Based on periodic review of abnormal situation logs prepared by these decision makers, information for modification of plant safeguards system or for verification of correct design and proper functioning.

N. From production control manager

(4) 1. Abnormal situation information
   a. Investigative
   b. Innocent cause
   c. Resolution

(15) 2. Production information
   a. Production control data
   b. Changes in process operations
   c. Changes in plant-specific rules, regulations and procedures

(6) 3. Information from periodic review of safeguards related production control rules, regulations and procedures for verification of assurance statements and of correctness of design and proper functioning of safeguards system

(7) 4. Other information
   a. Safeguards system design and modification information
   b. Diversion path analysis information
   c. Observations of process area activities
   d. Notification of problems arising from process area activities
   e. Assurance information

O. From physical security director

(4) 1. Abnormal situation information
   a. Discovery
   b. Investigative
   c. Innocent cause
   d. Resolution

(1) 2. Abnormal situation reports from subordinates
   a. Date and time of notification
   b. Identification of plant guard captain or plant guard
   c. Area of facility or perimeter involved
   d. Actions taken for abnormal situation verification
   e. Date and time plant safeguards authority, plant manager and FBI and/or local law enforcement authorities notified by physical security director if abnormal situation unresolved during allowed elapsed time
   f. Statement of resolution if abnormal situation cleared-up using information available to physical security director but not to plant guard captain
      1) Explanation of innocent cause, or

2) Description of operational error, or
3) Indicator of safeguards preventive system design error

(6) 3. Information from periodic review of safeguards aspects of physical security rules, regulations and procedures, preventive system analyses and abnormal situation reports for verification of assurance statements and of correctness of design and proper functioning of physical security system as it applies to safeguards

4. Preventive system analyses data

(16) 5. Law enforcement information from local FBI or law enforcement authorities about off-site events
   a. Discovery
      1) Illegal possession outside plant perimeter
      2) Cached outside plant perimeter
   b. Investigative
   c. Resoloution and/or recovery

(16) 6. Irregular event information
   a. Fires and accidents
   b. Demonstrations
   c. Natural disasters

(7) 7. Other information
   a. Safeguards system design and modification information
   b. Diversion path analysis information
   c. Observations concerning physical security system
   d. Notification of short term physical security problems, breach of physical security or irregular event which might require ad hoc response such as special inventory of area involved
   e. Assurance information

(17) P. From plant safeguards committee
1. Requests for information, suggestions, ad hoc studies and diversion path analysis summary reports and workpapers of specific unit processes or MBA's
2. Decisions of plant safeguards committee
   a. For plant safeguards authority activities
   b. To be passed to process engineer, R&D supervisior, analytical laboratory supervisior, vault manager, plant physical inspector and shipping dock foreman

(18) Q. From plant data processing (depending on sophistication of plant data processing system and facility-specific procedures and personnel responsibilities)
1. Facility-wide SNM accounting records
2. Physical inventory data
3. Current and prior period facility MUF data
4. Narrative explanations of prior period MUF
5. Current and prior period S-R data (inter- and intra-plant)
6. Analytical surveillance results and reports
7. Safeguards exception reports and alarms

(19) R. From plant manager
1. Requests for assurance information

2. AEC safeguards policy and related corporate policy
3. Results of AEC survey inspections as they relate to safeguards

S. From plant safeguards authority at another facility
1. S-R information and data
a. Notification
b. Investigation
c. Resolution
2. Other facility shipping
(20) a. Notification by telephone of shipment and estimated time of arrival
(21) b. Teletype (TTY) confirmation of shipment
1) Date and time of shipment
2) Estimated time of arrival
3) Items or containers shipped
a) Type
b) Quantity
c) Contents
d) Seal numbers
4) Carrier information
a) Transportation contractor identification
b) SNM transportation custodian identification (if applicable
c. Receiver's copies of Form AEC 741
3. Other facility receiving
(20) a. Notification by telephone of receipt
(22) b. Teletype (TTY) confirmation of receipt
1) Date and time of receipt
2) Items or containers received
a) Type
b) Quantity
c) Condition
d) Seal numbers
c. Shipper's copies (returned from receiver) of Forms AEC 741 and/or AEC 284

(23) T. From regional transportation control
1. Notification of transportation abnormal situation involving facility shipment
2. Requests for additional information
3. Investigative information
4. Resolution information

(24) U. From AEC survey inspector
1. AEC safeguards policy and directives
2. Results of AEC sponsored R&D applicable to facility safeguards system
3. Requests for additional samples during on-site evaluation
4. Requests for additional information on any safeguards related phase of facility activity during on-site or off-site evaluation
5. Preliminary findings, suggestions and recommendations made during exit interview

(25) V. From SS rep
1. Requests for information, resolution or investigation of specific safeguards situations and/or problems
2. Follow-up information on suggestions or recommendations
3. Results of AEC sponsored R&D applicable to facility safeguards system
4. Off-site analytical laboratory results (when applicable)
5. AEC safeguards policy and directives

W. From NMIS

(26) 1. Requests for information about shipments and receipts
a. S-R
b. Measurement uncertainties
c. Data verification
d. Resolution information
2. Material transaction error reports
3. Material accounting balance for plant verification

II. INFORMATION AND DATA GENERATED AT THIS NODE
A. Information for diversion path analyses
B. Analytical surveillance data
C. Analytical surveillance exception data
D. Information for safeguards system design and modification
E. Abnormal situation existence verification
F. Abnormal situation investigation and resolution information
G. Elapsed time information
H. Assurance information

III. RECORDS MAINTAINED AT THIS NODE
A. Diversion path analyses

(27) B. Safeguards system design records
1. Design plans
2. Suggested modifications forwarded by facility personnel

(28) C. Abnormal situation records (all sources)
1. Notifications
2. Investigations
3. Innocent causes
4. Resolutions

(29) D. Safeguards policy
1. AEC
2. Corporate

E. Plant-specific rules, regulations and procedures for production, R&D and laboratory activities which interact with safeguards activities

F. Historical AEC survey inspection records as they relate to safeguards

G. Plant safeguards committee recommendations, decisions and requirements

(30) H. Current and historical records (may be maintained by plant data processing system for rapid recall by plant safeguards authority
1. Analytical surveillance
2. S-R
3. MUF
4. Uncertainty of MUF
5. Inventory

6. Routine physical inspections
7. Calibration program
8. Transportation
9. Material receipt and transfer (inter- and intra-plant)
10. Item identity change
11. Assurance records

IV. RECORDS AND REPORTS PREPARED AT THIS NODE

A. Diversion path analyses
B. Safeguards system design and modification reports
C. Plant-specific rules, regulations and procedures for safeguards activities
D. Records of assurance statements
(31) E. Abnormal situation reports
1. Date and time of notification
2. Identification of notifier
3. Area of facility involved
4. Actions taken for abnormal situation verification
5. Date and time physical security director, plant manager and FBI and/or local law enforcement authorities (through physical security director) notified by plant safeguards authority if abnormal situation unresolved during allowed elapsed time
6. Statement of resolution if abnormal situation cleared-up using information available to plant safeguards authority but not to other plant personnel
a. Explanation of innocent cause, or
b. Description of operational error, or
c. Indicator of safeguards system design error
F. Reports to plant safeguards committee
G. MUF and uncertainty of MUF records
H. Shipper's copies of Form AEC 741 and receiver's copies of Forms AEC 741 and AEC 284
I. Safeguards activity reports
J. Assurance reports

V. OUTGOING INFORMATION FLOWS FROM THIS NODE

(32) A. To process engineer
1. Diversion path analyses for his process area
2. Abnormal situation information
a. Elapsed time allowed before notifying next echelon (each type of abnormal situation)
b. Innocent cause or resolution
c. Feedback
3. Solutions to problems
4. Decisions of plant safeguards committee
5. Safeguards policy from plant management
(33) B. To R&D supervisor
1. Diversion path analyses for his R&D area
2. Abnormal situation information
a. Elapsed time allowed before notifying next echelon (each type of abnormal situation)
b. Innocent cause or resolution
c. Feedback

3. Solutions to problems
4. Requests for special R&D
5. Decisions of plant safeguards committee
6. Safeguards policy from plant management

(34) C. To analytical laboratory supervisior
1. Diversion path analyses for his analytical laboratory area
2. Abnormal situation information
   a. Elapsed time allowed before notifying next echelon (each type of abnormal situation)
   b. Innocent cause or resolution
   c. Feedback
3. Solutions to problems
4. Requests for information and data
   a. Calibration program
   b. Measurement uncertainties
   c. Non-routine measurements
   d. Special samples
5. Decisions of plant safeguards committee
6. Safeguards policy from plant management

(35) D. To vault manager
1. Solutions to problems arising from vault activities
2. Abnormal situation information
   a. Elapsed time allowed before notifying next echelon (each type of abnormal situation)
   b. Innocent cause or resolution
   c. Feedback
3. Decisions of plant safeguards committee
4. Safeguards policy from plant management

(36) E. To plant physical inspector
1. Solutions to inspection activity problems
2. Abnormal situation information
   a. Elapsed time allowed before notifying next echelon (each type of abnormal situation)
   b. Innocent cause or resolution
   c. Feedback
3. Decisions of plant safeguards committee
4. Safeguards policy from plant management

(37) F. To shipping dock foreman
1. Solutions to shipping dock activity problems
2. Decisions of plant safeguards committee
3. Safeguards policy from plant management
4. Receiving activities
   a. Notification of material to be received (may be Teletype (TTY) notification by shipper)
   b. Routing for material to be transferred on-site after receipt
   c. Abnormal situation information
      1) Elapsed time allowed before notifying next echelon (each type of abnormal situation)
      2) Innocent cause or resolution

3) Feedback

5. Shipping activities
   a. List of items and/or containers to be shipped
   b. Authorization for shipment
   c. Bill of lading to accompany shipment
   d. Shipping labels
   e. Information on seals
   f. Designation of carrier
   g. Information for verification of credentials of SNM transportation custodian
   h. Special handling instructions
   i. Abnormal situation information
      1) Elapsed time allowed before notifying next echelon (each type of abnormal situation)
      2) Innocent cause or resolution
      3) Feedback

(38) G. To plant guard captain
   1. Notification of abnormal situation where immediate action may result in apprehension and recovery
   2. Notification of recovery of misplaced material

(39) H. To production control manager
   1. Change in safeguards system necessitating modified production regulation or procedure
   2. Safeguards policy decisions from plant management
   3. Safeguards system design and modification reports
   4. Diversion path analysis reports

(40) I. To physical security director
   1. Modifications in safeguards system which require modified plant-specific physical security rules, regulations or procedures
   2. Safeguards policy decisions from plant management
   3. Diversion path analysis reports

J. To plant safeguards committee

(41) 1. Information and data specifically requested
   a. Details of facility activities relevant to safeguards
      1) Operational activities
         a) Material flows
         b) Material residence times
         c) Material attractiveness
         d) Changes in material form (physical or chemical)
         e) Quality control measurements
         f) Process control measurements
         g) Measurement programs
         h) Measurement points and techniques
         i) Statistical analyses of measurement data
         j) MUF and uncertainty in MUF calculations and supporting information
      2) Current and prior period accounting information
      3) Manuals specifying facility rules, regulations and procedures
         a) SNM control

b) Internal control
c) Process control
d) Quality control
e) Health and safety
f) Physical security

4) Corporate safeguards policy

b. Details of facility safeguards system

1) Design
2) Modifications since last AEC survey or meeting of committee
3) Diversion path analyses
a) Abnormal situations considered
b) Ranking and coverage
c) Available variables
d) Indicator chosen
e) Mass, time and space sensitivity of selected indicator
4) Mass, time and space sensitivity of overall system

c. Abnormal situation logs

1) Log entries
2) Responses
3) Innocent causes
4) Resolutions
5) Frequency of entries
6) Modifications to abnormal situation responses resulting from analysis of abnormal situation log entries

d. Allowable elapsed times for specific abnormal situations
e. Assurance information

(41) 2. Results of ad hoc studies
3. Suggestions and recommendations
4. Diversion path analysis summary reports and workpapers
5. Diversion path analysis up-date information necessitated by changes in process operations or production-control or (42) physical-security rules, regulations and procedures
6. Assurance reports
7. Records and reports for periodic review by committee

a. Abnormal situation records and reports
b. Current and prior period accounting records and reports
c. MUF records
d. Safeguards system design and modification records and reports
e. Safeguards activity reports
f. Assurance statement records
g. AEC survey inspection records
h. Rules, regulations and procedures
i. Safeguards policy records

(41) 8. New information for committee action or review and/or follow-up information

a. Abnormal situation information, alerts and intelligence from any source

b. Information from process engineer, R&D supervisor, analytical laboratory supervisor, plant physical inspector and shipping dock foreman concerning their areas of responsibility
   1) Periodic reviews of plant-specific rules, regulations and procedures
   2) Safeguards system design and modification suggestions
   3) Diversion path analysis information
   4) Observations of activities
   5) Notification of problems
   6) Assurance
c. Periodic reviews of abnormal situation logs, diversion path and preventive system analyses
d. Inter- and intra-plant S-R
e. MUF evaluations
f. Breach of physical security which poses safeguards problem
g. Irregular event information
h. Investigations of specific abnormal situations
i. Verification of assurance statements and of correctness of design and proper functioning of overall plant safeguards system
j. Results of AEC surveys and follow-ups

9. Problems having safeguards significance which require AEC and/or corporate decisions to effect solution
(41) 10. Information for follow-up to Field Office suggestions or recommendations
11. Assurance information

(43) K. To plant data processing
1. Requests for information and data (facility-wide, MBA or unit process)
   a. SNM accounting records
   b. Physical and book inventory data
   c. Current and prior period MUF data, uncertainty of MUF and narrative explanations
   d. Current and prior period S-R data (inter- and intra-plant)
   e. Analysis results and reports
      1) Analytical surveillance
      2) Safeguards exception reports

L. To plant manager
(44) 1. Abnormal situation information, alerts and intelligence
   a. Discovery
      1) Material missing, misplaced or found on-site
      2) Material found outside plant perimeter
         a) Illegal possession
         b) Cached
      3) Covert threat to plant
   b. Investigative
      1) On-site
         a) Plant personnel findings

b) FBI findings
2) Off-site
a) Local law enforcement agency findings
b) FBI findings
c. Innocent cause
d. Resolution and/or recovery

(45) 2. Abnormal situation reports
a. If plant safeguards authority is discoverer
1) Date and time of discovery
2) Identification (man- or badge-number) of discoverer
3) Complete statement of pertinent facts
a) Material type
b) Quantity
c) Location
d) Analytical surveillance indicator
e) Diversion path description
f) Initial actions taken
4) Date and time production control manager, physical security director, plant manager, SS rep and FBI and/or local law enforcement authorities (through physical security director) notified by plant safeguards authority if abnormal situation unresolved during allowed elapsed time
5) Statement of resolution if abnormal situation cleared-up using information available to plant safeguards authority
a) Explanation of innocent cause, or
b) Description of operational error, or
c) Indicator of safeguards system design error
b. If process engineer, R&D supervisor, analytical laboratory supervisor, vault manager, plant physical inspector, shipping dock foreman, plant guard captain, production control manager or physical security director is discoverer
1) Date and time of notification
2) Identification of notifier
3) Area of facility or perimeter involved
4) Actions taken for abnormal situation verification
5) Date and time production control manager, physical security director, plant manager, SS rep and FBI and/or local law enforcement authorities (through physical security director) notified by plant safeguards authority if abnormal situation unresolved during allowed elapsed time
6) Statement of resolution if abnormal situation cleared-up using information available to production control manager, physical security director or plant safeguards authority but not to discoverer
a) Explanation of innocent cause, or
b) Description of operational error, or
c) Indicator of safeguards system design error

(46) 3. Administrative information
   a. Safeguards system design and modification reports
   b. Safeguards activity reports
   c. Diversion path analysis summary reports
   d. Assurance reports
(47) 4. Other information
   a. Problems having safeguards significance which require AEC and/or corporate decision to effect solution
   b. Assurance information

M. To plant safeguards authority at another facility
(48) 1. S-R information and data (see I.S.1.)
2. Teletype (TTY) confirmation of shipments or receipts
(21) a. This facility shipping (see I.S.2.b.)
(22) b. This facility receiving (see I.S.3.b.)

N. To regional transportation control
1. Teletype (TTY) confirmation of shipments or receipts
(21) a. This facility shipping (see I.S.2.b.)
(22) b. This facility receiving (see I.S.3.b.)

O. To AEC survey inspector
(49) 1. Details of facility activities relevant to safeguards (same as V.J.1.)
2. Records and reports associated with safeguards (see V.J.7.)
(50) 3. Assurance information and records

P. To SS rep
(44) 1. Abnormal situation information, alerts and intelligence (same as V.L.1.)
(45) 2. Abnormal situation reports (same as V.L.2.)
(51) 3. Copies of Forms AEC 741 and/or AEC 284 for receipts and Form AEC 741 for shipments
(52) 4. Safeguards system design and modification reports
5. Safeguards activity reports
6. Diversion path analysis summary reports
(53) 7. Problems having safeguards significance which require AEC decision to effect solution
8. Follow-up information on Field Office suggestions or recommendations
9. Assurance information

Q. To NMIS
1. Forms AEC 741 and AEC 284 information on receipts and shipments (if facility has direct input)
(26) 2. S-R information
3. COEI information

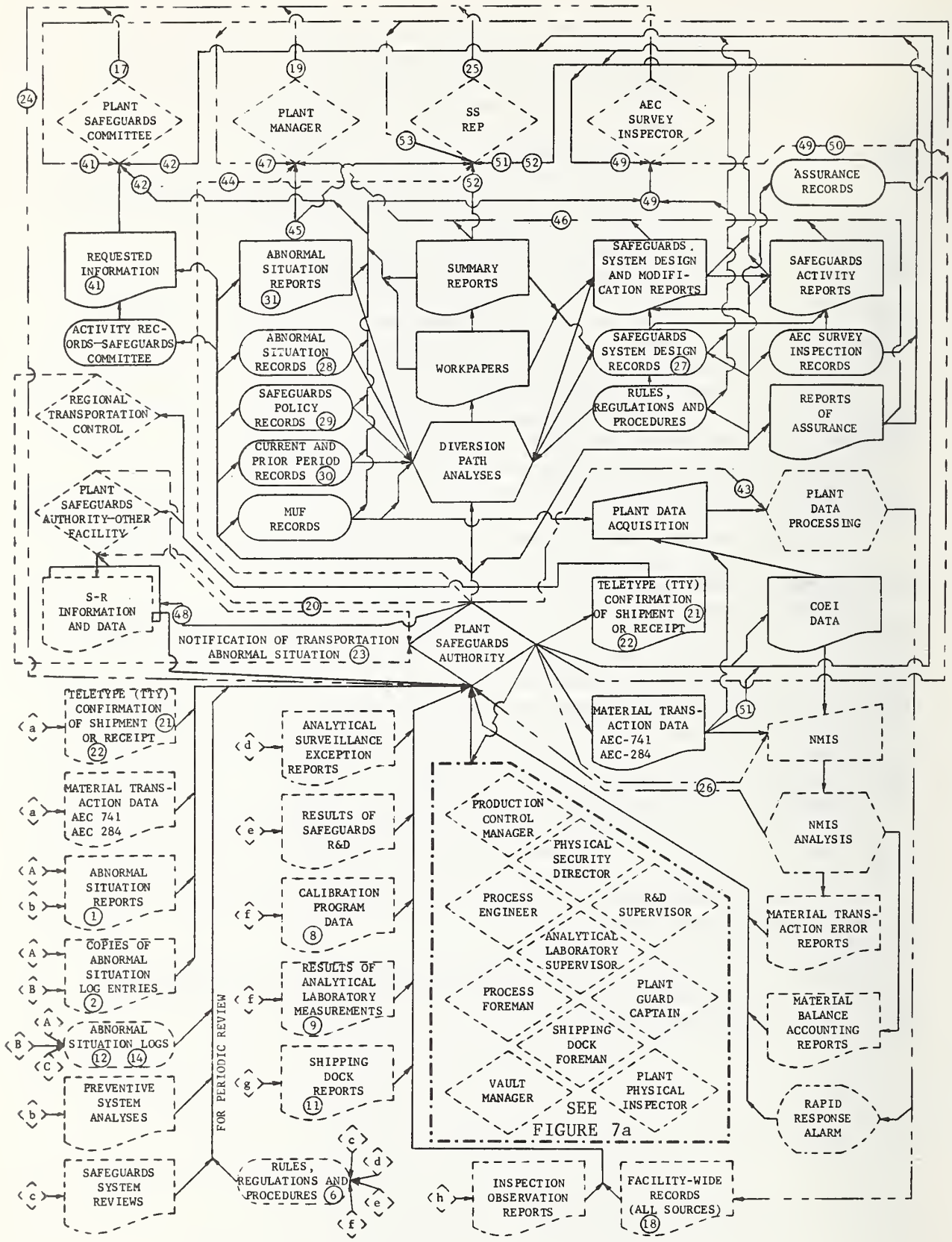

Figure 7 SIS Information Flows Associated with PLANT SAFEGUARDS AUTHORITY

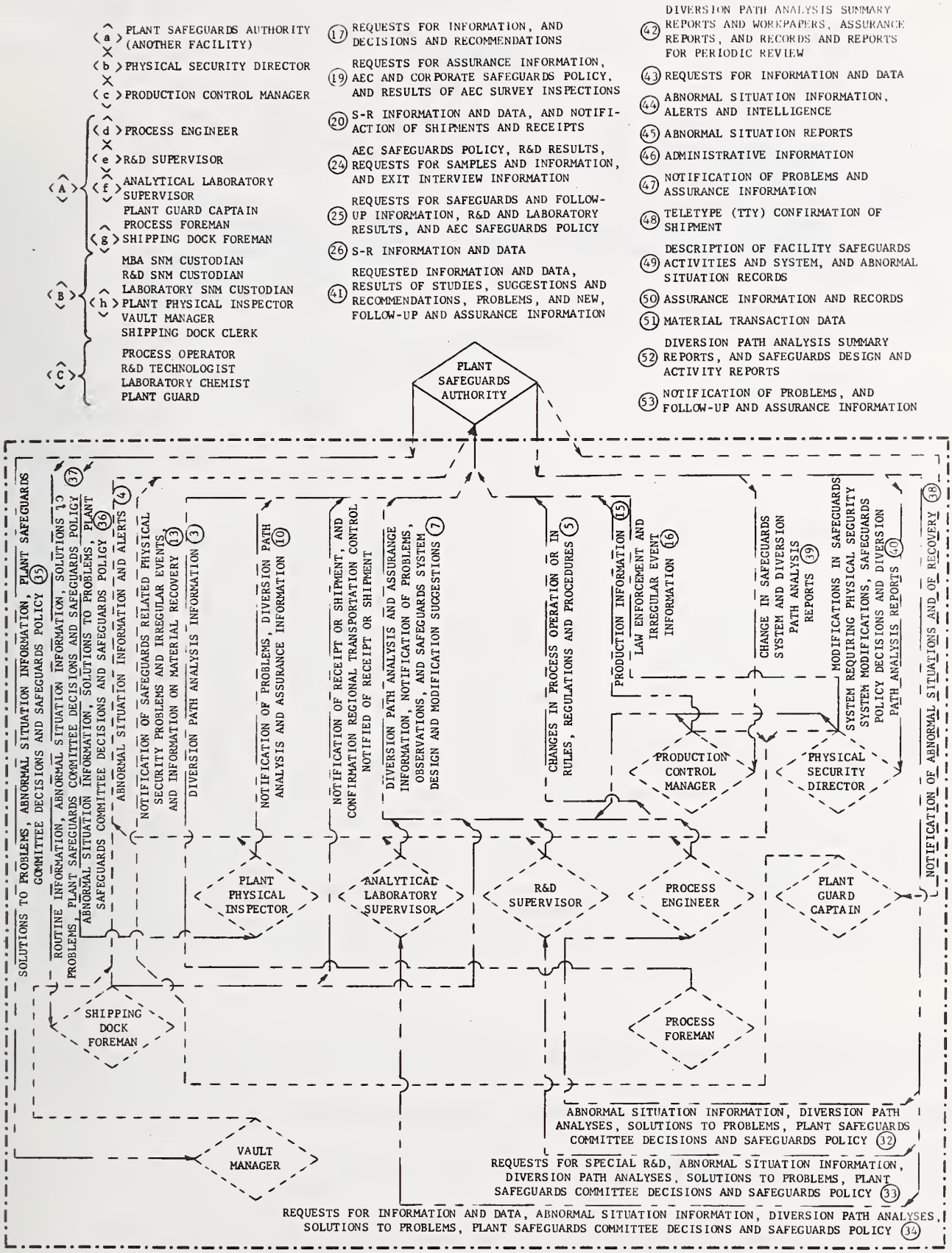

Figure 7a SIS Information Flows Associated with PLANT SAFEGUARDS AUTHORITY

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

Increasing use of nuclear material imposes additional emphasis on safeguards. The Technical Analysis Division, NBS, has been assisting the AEC in performing systems studies directed to safeguards for nuclear materials. A Safeguards Information System (SIS) is being developed so as to provide the information and decision structure needed for assurance that significant diversion to unauthorized use has not occurred in the past and, further, that any significant diversion which might in future occur will be detected in a timely manner. Although a comprehensive report is in preparation, a preview is considered useful at this time in order to familiarize plant personnel, charged with development of plant safeguards information systems, with aspects of SIS. This report thus reflects material from the forthcoming report and directs attention to the information flows related to the key safeguards decision maker within the plant - the plant safeguards authority. Terms and concepts are defined and their application is illustrated in the general case by highlighting decision responsibilities and details of the safeguards information flows associated with him.

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

Nuclear materials information systems; Nuclear materials safeguards; Safeguards

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