SANDIA REPORT SAND81-0646 • Unlimited Release • UC-41

Printed January 1982

MASTER

Guidance for Implementing an Environmental, Safety, and Health-Assurance Program

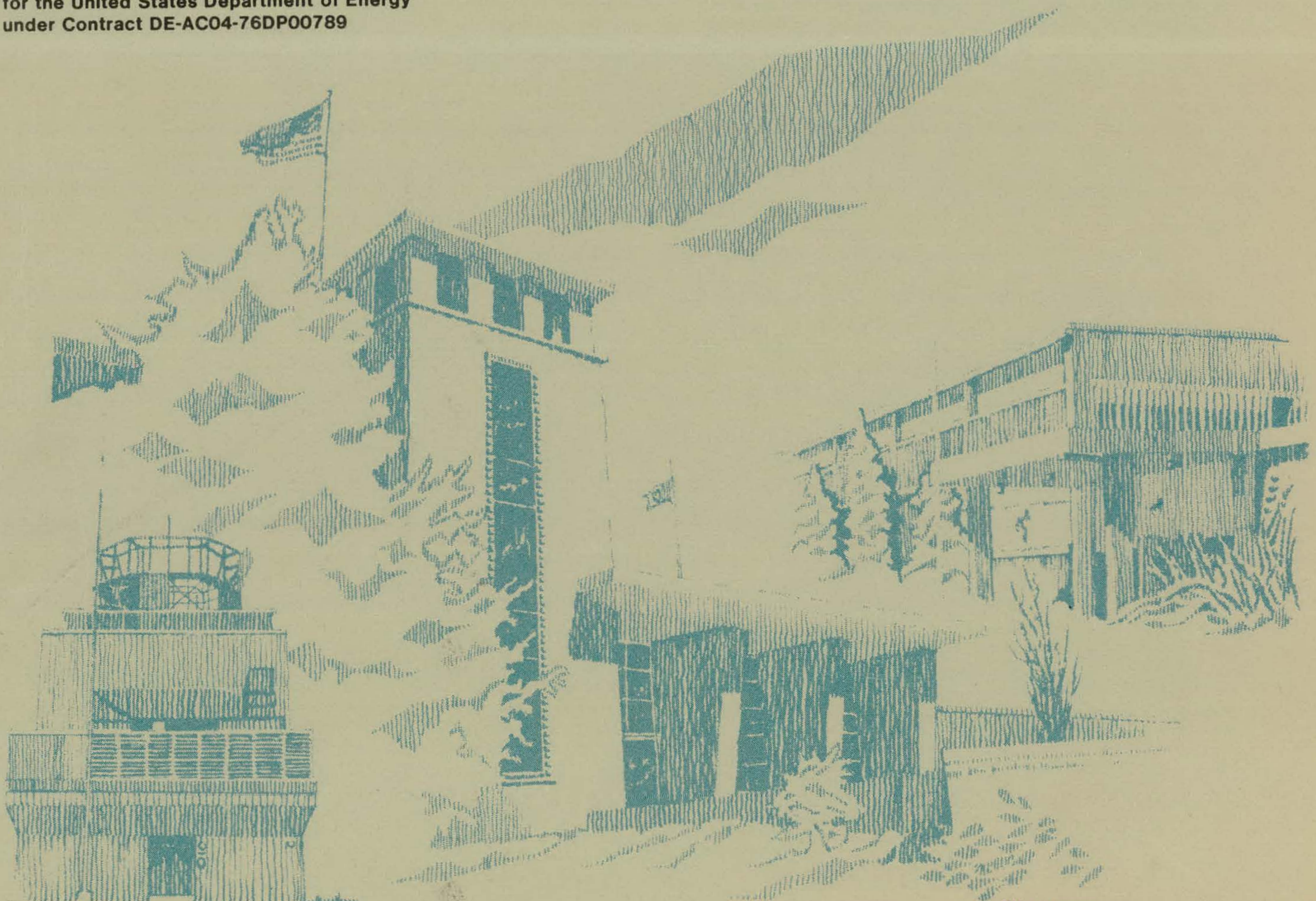
Volume 15. A Model Plan for Line Organization Environmental, Safety, and Health-Assurance Programs

NOTICE

PORTIONS OF THIS REPORT ARE ILLEGIBLE. It has been reproduced from the best available copy to permit the broadest possible availability.

Andrew C. Ellingson, Charles A. Trauth, Jr.

Prepared by
Sandia National Laboratories
Albuquerque, New Mexico 87185 and Livermore, California 94550
for the United States Department of Energy
under Contract DE-AC04-76DP00789



SF2900Q(8-81)

DISCLAIMER

Issued by Sandia National Laboratories, operated for the United States Department of Energy by Sandia Corporation.

Printed in the United States of America
Available from
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161

NTIS price codes
Printed copy: $7.00
Microfiche copy: A01

SAND81-0646
Unlimited Distribution
Printed January 1982

UC-41

SAND--81-0646

DE82 008624

GUIDANCE FOR IMPLEMENTING AN ENVIRONMENTAL, SAFETY, AND HEALTH-ASSURANCE PROGRAM

Volume 15. A Model Plan for Line Organization Environmental, Safety and Health Assurance Programs

Andrew C. Ellingson
Charles A. Trauth, Jr.
Special Projects Division, 1418

ABSTRACT

This is 1 of 15 documents designed to illustrate how an Environmental, Safety and Health (ES&H) Assurance Program may be implemented. The generic definition of ES&H Assurance Programs is given in a companion document entitled "An Environmental, Safety and Health Assurance Program Standard." This particular document presents a model operational-level ES&H Assurance Program that may be used as a guide by an operational-level organization in developing its own plan. The model presented here reflects the guidance given in the total series of 15 documents.

Acknowledgments

This work was sponsored by the Department of Energy (DOE), and among those many persons at the DOE who have been supportive and helpful, we would like to especially thank Messrs. Hal Hollister, John O'Connor, Mike Dix (now retired), and Ruben Pritchard for their support, encouragement, and patience. In addition, Mr. L. M. Jercinovic, and Mrs. Margaret Carroll of Sandia National Laboratories are owed many thanks for their valuable technical inputs, discussions, and reviews. Ms. Karen Marston-Fox of Tech. Reps., Inc., deserves plaudits for her fine reviews and editorial efforts.

CONTENTS

ILLUSTRATIONS

ILLUSTRATIONS (Continued)

A MODEL PLAN FOR LINE ORGANIZATION ENVIRONMENTAL, SAFETY AND HEALTH ASSURANCE PROGRAMS

Introduction

This is 1 of a set of 15 guidance documents designed to illustrate how an Environmental, Safety and Health (ES&H) Assurance Program may be implemented. The generic definition of ES&H Assurance Programs is given in a companion document entitled "An Environmental, Safety and Health Assurance Program Standard,"[1] often referred to as simply the Standard or the Program Standard. As suggested by the title, the Program Standard defines the functions and some of the structure needed within an institution for it to possess an "ES&H Assurance Program." The Standard is, on the other hand, relatively generic, flexible, and nonprescriptive--focusing on the general framework of ES&H Assurance Programs and on *what functions must be performed, not* on *how* these may be accomplished. This was done intentionally in order to provide maximum flexibility in implementation.

The ES&H Assurance Program Standard requires that an institution possess an independent "ES&H Staff." The remainder of the institution is considered "Line" and "Management" as suggested in Figure 1.* Generic functions of these three organizational components, as required by the Standard, are delineated in Figure 1. The Program Standard is more explicit about the nature of these functions. Specifically, Line organization *plans* are required--and these must reflect the *guidance* from the ES&H Staff, which itself must prescribe activities consistent with the Standard. In addition, the total program, planned by the ES&H Staff and approved by management, must be well

*Management in this context refers to *upper* (or institutional) management, with the Line organization presumed to have its own managerial hierarchy--designated Line management.

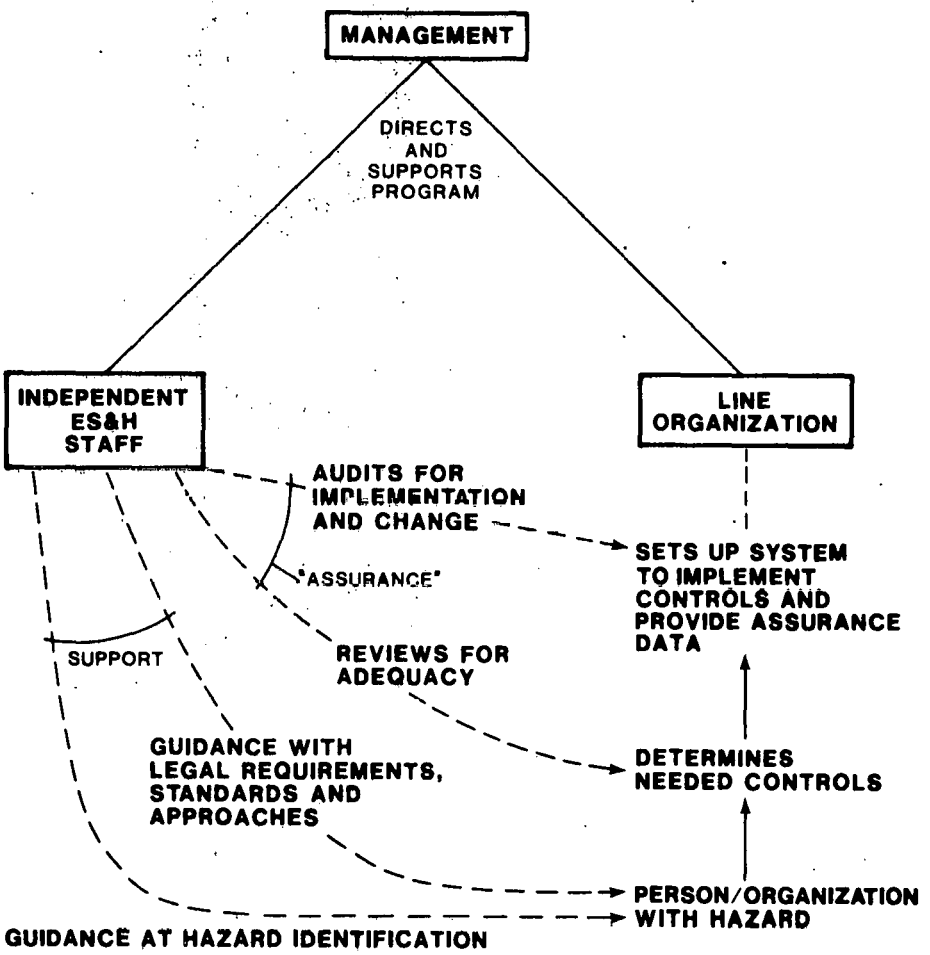


Figure 1. Institutional Structure and Generic Functions in ES&H Assurance Programs

defined. Thus, as illustrated in Figure 2, certain documentation must exist within the ES&H Assurance Program.

The intent of this series of guidelines is to provide an *illustration of this documentation*. No suggestion is intended that the program definition given in these guidelines provides a unique or even the most cost-effective means of performing the functions required by the Program Standard. Certainly, it is not intended that they are mandatory requirements stemming from the Program Standard.

We feel, however, an obligation to present one relatively specific program definition that effectively and (we believe) efficiently meets the requirements of the generic Program Standard in order to

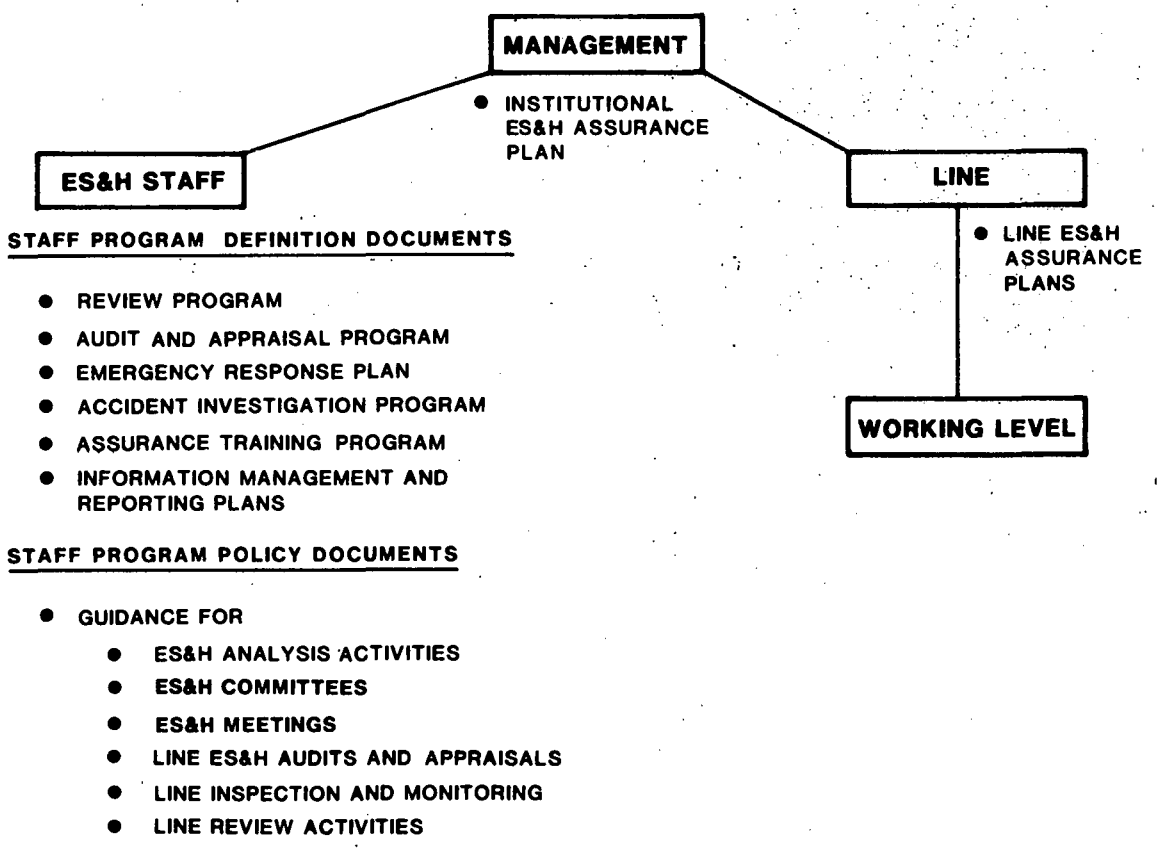


Figure 2. ES&H Assurance Program Documentation

- Demonstrate the feasibility of the Standard,
- Provide a specific, well-defined program that can be tested for cost-effectivity, and
- Aid others in structuring programs that are consistent with the Standard.

It was precisely with this in mind that this set of guidance documents was prepared. The set, generically entitled "Guidance for Implementing an Environmental, Safety and Health Assurance Program," consists of the following documents (see also References):

I. Institutional Models and ES&H Staff Program Documents

Volume 1 A Model Plan for Institutional Environmental, Safety and Health Assurance Programs[2]

Volume 2 A Model Plan for Environmental, Safety and Health Staff Audits and Appraisals[3]

Volume 3 A Model Plan for Environmental, Safety and Health Staff Review Activities[4]

Volume 4 A Model Plan for Institutional Emergency Response Programs[5]

Volume 5 A Model Plan for Institutional Accident Investigations[6]

Volume 6 Model Documentation for an Environmental, Safety and Health Assurance Information System[7]

Volume 7 A Model Plan for Institutional Environmental, Safety and Health Assurance Training Programs[8]

II. Model ES&H Staff Guidance Documents

Volume 8 Model Guidelines for Line Organization Environmental, Safety and Health Committee Operations[9]

Volume 9 Model Guidelines for Environmental, Safety and Health Analysis Activities[10]

Volume 10 Model Guidelines for Line Organization Environmental, Safety and Health Audits and Appraisals[11]

Volume 11 Model Guidelines for Line Organization Environmental, Safety and Health Review Activities[12]

Volume 12 Model Guidelines for Line Organization Environmental, Safety and Health Inspection and Monitoring Activities[13]

Volume 13 Model Guidelines for Line Organization Environmental, Safety and Health Meetings[14]

Volume 14 Model Guidelines for Utilizing Quality Assurance Support in Environmental, Safety and Health Assurance Programs[15]

III. Model Line ES&H Plans Which Reflect the Above Model Policies and Plans

Volume 15 A Model Plan for Line Organization Environmental, Safety and Health Assurance Programs[16]

Background

Management Obligations in ES&H Areas

Because many hazards associated with today's operations or with new products themselves have the *potential* for impacting large numbers of people--and because many of those *at risk* cannot exercise direct control over that risk--*management* in today's environment *has an obligation to exercise controls that lead to an acceptable perceived level of risk by those at risk.*[17,18] This may seem a debatable moral statement, but in many cases it has the force of law. In fact,

- When expending federal funds on programs that could have a public or environmental impact, the National Environmental Policy Act[19] and subsequent regulation mandate elaborate procedures for public input designed to ascertain public acceptability.
- Portions of the Occupational Safety and Health Act[20] are designed to ascertain acceptability to employees.
- Most ES&H laws and regulations are designed to *express* societally acceptable levels of control and/or permit public input with the same end result.

Among other things, this basic management obligation requires that *management decisions consider*, to an appropriate extent, *ES&H objectives of employees and the public* on a routine and thorough basis. And, in addition, it becomes a management obligation to keep those at risk informed in a credible fashion about protection efforts being undertaken on their behalf.

The ES&H Assurance Program Standard was designed to assist in meeting these obligations of today's management. How it does this is described in more detail in References 17 and 18.

Criteria for Meeting Management Obligations

ES&H programs based on the ES&H Assurance Program Standard are intended to satisfy six basic generic criteria for "success" in ES&H programs. By design, the *intent* of these six basic criteria is to provide a *measure* of *program* performance that does not rely solely on accidents or incidents; so that one's *positive steps* to provide protection to humans and their environment can be used, in part, to describe one's *success*. These six criteria may be described briefly as follows. (More detail can be found in References 10, 17, and 18.)

I. Identify all significant hazards, specifically or by class.

"Hazards" are defined as *things* which have the *potential* for causing injury to or illness in humans or damage to the environment. The environmental and human categories in which possible impact is of concern are shown in Figure 3. These are discussed in detail in Reference 10. *Unusual* hazards are defined as those hazards not routinely encountered and accepted by the general public, while *routine* hazards are all others, that is, those that *are* routinely encountered and accepted by the general public. Either type of hazard may be *significant*.

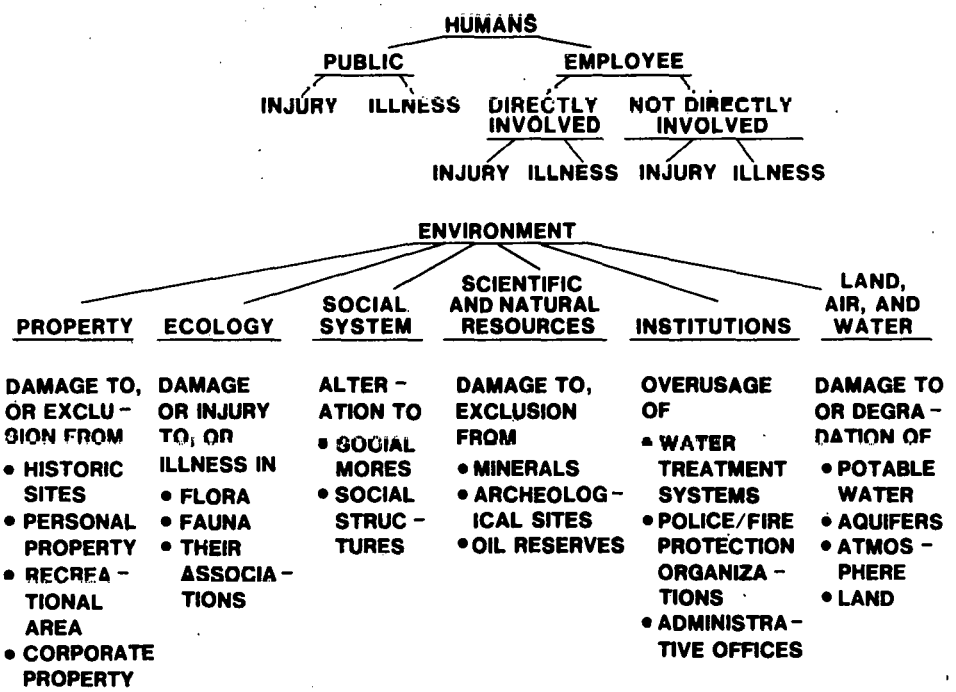


Figure 3. Human and Environmental Categories of Concern in ES&H Assurance Programs

II. Define acceptable controls over the significant hazards.

Acceptable controls are developed through an assessment or analysis process (see Reference 10, Volume 9 in this series) which examines the ways (*events*) through which the potential *consequences* (that is, possible types and scope of injury, illness, or damage) of hazards may actually be incurred. Possible controls over the *factors* that affect how these events occur are then identified, and a collection of controls which appears to be cost-effective and acceptable to

persons who might be harmed, or whose environment might be damaged, is then selected.

III. Routinely use the controls as they have been defined.

One of the major contributory factors in accidents or incidents involving significant hazards is the failure to *use* defined controls. "Use," here, is intended to imply implementation, use, and/or maintenance. This is discussed in Reference 21. In order to verify control use, an adequate definition of each control is needed.

IV. Accommodate changing circumstances.

In a way, this is intended to imply only that activities for meeting Criteria I, II, and III are routinely and systematically reviewed and updated, as required. The possibility always exists that new hazards will be introduced into an operation or that factors affecting the nature or scope of, or the likelihood of incurring, consequences from existing hazards will be modified. When such changes do occur, their effect upon the adequacy and reliability of controls must be analyzed and appropriate adjustments made, when necessary.

V. Define an emergency response program consistent with existing hazards and routinely verify its reliability.

There is, of course, no zero risk. In the above framework, acceptable controls carry with them a connotation of *acceptable risk*. One must therefore assume that accidents or incidents will occur--and prepare accordingly. The ES&H Assurance Program Standard requires an emergency response program based on the understanding of the potential consequences that may arise from a hazard and the events (or sequences of events) that may lead to their realization that is gained in the performance of activities which satisfy Criterion II, above.

VI. Provide reliable independent evidence that Criteria I through V are satisfied.

This is the *assurance function* implied in the title of the ES&H Assurance Program Standard. Assurance is accomplished through independent reviews and audits which are efficiently based on information provided by those responsible for an operation or a product.

The primary intent of ES&H Assurance Programs is to provide independent credible *evidence* that Criteria I through V are properly

satisfied. These first five criteria are designed to provide a *systematic* means for the *management of hazards* and may be thought of as defining the objectives of a *control subprogram* of the total ES&H Assurance Program, including both *direct controls* over hazards and *indirect administrative controls*. The latter are designed to provide a management system in which the direct controls are *defined*, and are routinely *used*, and which generates *verifiable evidence* that this is the case.

Assurance is then provided by an overlay subprogram which *verifies* the *adequacy* and *use* of the controls using the verifiable evidence just described. Specifically, *adequacy* is typically verified through document *reviews* (of plans, procedures, etc.), while the *use* of the controls is verified through *audits* and *monitoring actions*. Independent reviews by the institutional ES&H Staff form the basis for credibly reporting on the positive efforts made to protect humans and their environment. In addition, data maintained by the ES&H Staff form a hypothesis about institutional performance that may be efficiently verified by statistical sampling methods by external agencies, as appropriate. The efficiency of performance verification sampling by both the ES&H Staff and external agencies is discussed in Reference 22.

The Role of a Line Organization Plan in Satisfying These Criteria

The assurance aspect of an ES&H Assurance Program requires a continuing determination of the adequacy and use of the program, and the judgment of adequacy is possible only when the program is well defined. The ES&H Assurance Program Standard requires ES&H Assurance Plans at the various organizational levels in order to meet this need for definition.

The Standard also assigns the *basic responsibility for ES&H protection* to Line management, so that the ES&H Assurance Plans of the Line organizations are particularly important to the overall program definition--and the working level* Line organization plan is the keystone of these. It is the working level of the Line organization at

*"Working level" is a flexible concept in the Standard but is intended to denote approximately the first or second level of management. This is the level at which the *control subprogram* noted above is most conveniently implemented.

which interfaces with the hazards involved in an institution's operations take place. ES&H plans at this level describe the basic approach that has to be taken to satisfy all six of the criteria in the previous section. The plan includes a description of the evidence of performance that is to be maintained at the working level, how and when it is to be generated, and by whom it is to be maintained and verified.

The next section presents and discusses a model Line organization plan that satisfies the requirements of the Standard.

An Annotated Model Plan for Line Organization Environmental, Safety and Health Assurance Programs

The Model Plan for Line Organization Environmental, Safety and Health Assurance Programs presented here provides the definition for the basic unit of an institution's ES&H assurance program--the program of the working level Line organization (identified as "Department" in this model). Although plans are also required by the Standard for Line organization levels above the working level, such plans may be quite brief since they primarily express support and define an oversight function for the working level programs. In what follows, italicized portions of the text define the model, while comments about the model are in roman type.

This Department's Environmental, Safety and Health Plan

Scope

This Department's Environmental, Safety and Health (ES&H) Plan expresses the Departmental ES&H policy and defines the Departmental ES&H control and assurance functions that are to be performed. The plan is structured around a Departmental ES&H Committee, which performs assigned ES&H functions on behalf of the Department Manager.

Policy

The Department regards the health and safety of its personnel and the public, and the protection of the environment, as fundamental aspects of its responsibilities. Accordingly, it is Departmental policy to conduct its operations with a regard for safety, health, and the environment that is second to none.

As a further matter of policy, environmental, safety, and health considerations are an integral part of all Departmental projects, extending from project conception through termination. The aim is not only to comply with legal requirements but to assure that risks to

employees, the public, and the environment are reduced to the lowest reasonable levels while still providing a cost-effective service. We regard the safety and health of employees and the public, and the protection of the environment, as basic criteria of the quality of the services we provide, and we will strive to provide evidence of a high level of performance in these areas.

This policy section of the model plan expresses the philosophy and policy of the Line organization's management. The Standard requires that "management shall issue an ES&H policy statement expressing the importance of ES&H and the intent to comply with ES&H requirements," and the statement given here meets this requirement.

An institutional ES&H assurance program, to meet the requirements of the Standard, must also express management's policy--at the institutional level. The working level management policy should be based upon that at the institutional level and may be viewed as a vehicle for transmitting institutional policy to working level personnel.

Management support, as implied in the policy statement, is extremely important in an ES&H assurance program because an assurance program is essentially a management system and cannot operate effectively apart from management.[17] An ES&H assurance program deals with almost every aspect of an organization's operation and thus is a "management tool."

Organization

The Department is composed of six Divisions, each reporting to the Department Manager, as shown in Figure 1. Also reporting to the Department Manager is the Departmental ES&H Committee.

The ES&H Committee is composed of three members from the personnel in the Department, each appointed by the Department Manager for a 1-year term. The terms are overlapping, so that a new member is appointed to the Committee every fourth month. Appointments are made so that no Division has more than one member on the Committee. Each member serves as Chairman during the last 4 months of his or her term, and also serves as an alternate member during the 4 months immediately following his or her term. The alternate acts as a member of the Committee whenever a regular member is absent. The Committee calls on the services of specialists, as needed. Each member of the Committee shall have completed

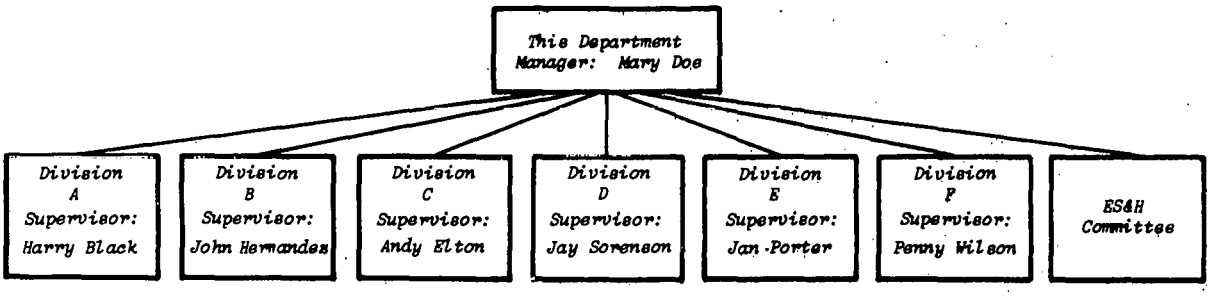


Figure 1. Departmental Organization Chart

the ES&H Committee Training Course provided by the ES&H Staff prior to assuming office. Current Committee membership is included in Departmental ES&H records as defined below.

The Chairman's duties include scheduling Committee meetings and activities, assigning tasks to Committee members, and maintaining custody of all ES&H records for the Department. The Department Secretary provides secretarial services for the Committee.

When the ES&H Committee reports directly to management, as it does in this model, a degree of independence for the Committee is achieved. Independence is important for the assurance arm of the organization because of the need for objective and unbiased evaluations in providing assurance. When the assurance group is part of the organization it is evaluating, as in this case, its function is termed "internal assurance," and complete independence is not possible. However, by reporting directly to management, some independence is obtained.

The Standard does not require the use of ES&H Committees--only that groups or individuals performing the internal assurance function have sufficient independence to evaluate program effectiveness. This means that if the Committee format is not used, some other means of providing independence must be found. Use of an ES&H Committee has advantages, in addition to achieving independence for the assurance function[9]:

- It provides for more thorough involvement of personnel in the ES&H program, particularly if the Committee is established on a rotational basis,

- It encourages routine, periodic training in ES&H matters for all personnel--again, particularly if rotation is used,
- It permits ES&H efforts to be administered with minimum impact on other activities because of the structured, well-defined nature of the Committee, and
- It provides a formal and convenient means of communication between personnel and management and between personnel and the ES&H Staff.

Assigned Responsibilities

The Department Manager is responsible for

- *Directing the preparation of, and approving, this ES&H plan and changes thereto,*
- *Obtaining approval of this plan from the Director,**
- *Reviewing the plan once each year,*
- *Appointing the ES&H Committee,*
- *Considering and approving ES&H-related actions taken by the ES&H Committee and the Division Supervisors, including documented consideration of ES&H Committee recommendations,*
- *Supporting the ES&H program through budget and time allocations, consideration of ES&H performance during merit reviews, attendance at ES&H meetings, and attendance at ES&H training sessions, and*
- *Arranging National Environmental Policy Act (NEPA) actions.*

Division supervisors are responsible for

- *Providing input to this ES&H plan, including information on Division facilities, activities, and hazards, and approval of the form in which this input is incorporated into the plan,*
- *Considering ES&H in all planning activities,*
- *Determining appropriate ES&H controls (with the assistance of the ES&H Committee and ES&H Staff, as needed),*
- *Arranging for reviews of project budgets, schedules, and purchase requisitions,*
- *Arranging for reviews, analyses, or tests of facility and equipment designs (and/or descriptions) and design changes,*

*Directors, in this model, are assumed to be the management level immediately above Department.

- *Identifying and controlling all program changes (including design, budget, schedule, and procedure changes) to the same extent that the initial program elements are controlled,*
- *Controlling and monitoring equipment and environmental conditions,*
- *Considering ES&H qualifications in making job assignments,*
- *Providing systematic consultation with appropriate specialists on all Division projects and documentation of such consultation,*
- *Assuring that Division personnel are familiar with this ES&H plan and have received training as required by the plan, and*
- *Assuring that this plan is implemented by Division personnel.*

The ES&H Committee is responsible for performing the assurance and assistance functions defined in the Program Requirements section, below.

Department personnel are responsible for

- *Providing assistance to supervision and the ES&H Committee in preparing inputs to this plan, as requested,*
- *Being familiar with this plan and the ES&H functions specified herein,*
- *Performing assigned tasks in a safe manner,*
- *Being alert for hazardous conditions and reporting these conditions to supervision and/or the ES&H Committee,*
- *Reporting all accidents to supervision and/or the ES&H Committee, and*
- *Participating in ES&H meetings and, on a rotational basis, on the ES&H Committee.*

This summary statement of responsibilities sets the stage for the detailed assignment of functions in the next section and also specifies some rather unique responsibilities of management and personnel. To highlight the emphases in this listing, note that

- Management is responsible for *direction* and *support* of the ES&H program,
- Supervision (first-line management) is responsible for *developing acceptable ES&H controls* and *enforcing their use*,
- The ES&H Committee is responsible for performing the *assurance* and *support* functions, and
- Personnel are responsible for *participating in*, and *following*, the ES&H program.

Program Requirements

This Department's ES&H program uses program elements specified in the ES&H Staff document, "Guidance for Line Organization Audits and Appraisals," to support the achievement of the following criteria:

- *The identification of significant hazards,*
- *The definition of acceptable controls over these hazards,*
- *The routine use (including maintenance) of the defined controls, and*
- *The provision of evidence that these things are done.*

"Controls" include those exercised in emergency situations and those exercised to accommodate change.

The program elements utilized in this Department include those given in the audit checklist of Appendix A. How these elements relate to the four criteria given above is summarized in Figures 2, 3, and 4--the program elements being identified by the checklist numbers (A2, D1, etc.). The details of the program elements are presented below as program requirements--specifying the functions performed, by whom they are performed, how and when they are performed, and what evidence is maintained that they are performed.

ES&H Committee

The ES&H Committee shall maintain and update this ES&H plan, including the Departmental ES&H Analysis in Appendix B. The ES&H analysis consists of three sections: a Facility/Project List (classified by type of hazard involved), a List of Hazard Sources (with associated potential impacts), and a Hazard Analysis and Mitigation section. Updating of the ES&H Analysis is to be accomplished through quarterly input from supervision and personnel and through consultation with the ES&H Staff organization and other specialists. This activity is conducted in accordance with the requirements in "Guidelines for Line Organization ES&H Committee Operations" and "Guidelines for ES&H Analysis Activities," issued by the ES&H Staff.

The Committee shall assist supervision in determining the need for special training for personnel assigned to tasks involving significant hazards and shall schedule such training with the ES&H Staff. The Committee shall also schedule the training of all personnel in emergency procedures. Training and retraining records will be kept as prescribed below.

CRITERION	RESPONSIBILITY (B1)	FUNCTION (B3)	EVIDENCE (C1,D10,D28)	INTERNAL ASSURANCE
IDENTIFY SIGNIFICANT HAZARDS (INITIALLY, AND ON A CONTINUING BASIS-- INCLUDING LOCATION, ORGANIZATION, PROJECT, ETC.	FIRST LINE SUPERVISOR (FOR OWN ORGANIZATION ONLY) (A4)	PROVISION OF FACILITY/ PROJECT DATA (D1) PROVISION OF HAZARD LIST (D1,D4) PROVISION OF PROPOSED CHANGES (D3,D27) MONITORING OF -BUDGETS -SCHEDULES -DESIGNS -PURCHASE REQUISITIONS - ETC. (D3,D8,D9, D10,D27) INSPECTION OF -OPERATIONS -EQUIPMENT -FACILITIES (D22,D27) REVIEWS OF -PLANS -DESIGNS -ETC. (D8,D9,D10, D27) ENVIRONMENTAL MONITORING (D22)	ES&H PLAN INPUTS AS MEMOS TO ES&H COMMITTEE INSPECTION, MONITORING FORMS AND REPORTS VERIFICATION SIGNATURES ON DOCUMENTS REVIEW REPORTS MONITORING DATA/RECORDS	○ FIRST CONCERN: PLAN REALLY BEING FOLLOWED (E9) ○ SECOND CONCERN PLAN LEADS TO DESIRED RESULTS (IN THIS CASE, THE IDENTIFICATION OF HAZARDS) (E9)
	PERSONNEL (D4)	INPUTS TO PLAN AS REQUESTED (D3,D4) PARTICIPATION IN ES&H MEETINGS (D4, D27) FORMAL REPORTS OF HAZARDOUS EQUIPMENT, FACILITIES, OPERATIONS (D16,D27) INFORMAL REPORTS TO ES&H COMMITTEE OR SUPERVISION (D27) FORMAL REVIEW ACTIVITIES, AS REQUESTED (D10)	MEMOS OR SUPERVISORY NOTES FORMS MEETING MINUTES FORMS COMMITTEE OR SUPERVISORY NOTES REVIEW REPORTS	VERIFIED THROUGH AUDIT (E6) ACTIVITIES BASED ON ○ OBSERVATION -I.E., INSPECTION ACTIVITIES (E2,E3, E4, E5, E7) ○ REVIEWS OF EVIDENCE (E1, E2, E8) ○ INTERVIEWS (E2, E7) USING LINE CONTROL PROGRAM ELEMENTS AS BASE EVIDENCE: ○ AUDIT PLAN SHEETS FOR EACH PROGRAM ELEMENT AND ANY SUMMARY MATERIAL GENERATED DURING AUDIT ○ AUDIT REPORT (E6)
	SPECIALISTS (AS REQUESTED, INCLUDING ES&H STAFF, CONSULTANTS, AND PERSONNEL FROM SA'S, RELIABILITY AND HUMAN FACTORS, SYSTEMS SAFETY, STANDARDS AND CALIBRATION, MATERIAL TESTING, AND TRAINING DEPARTMENTS) (B2, B5 B6)	INSPECTION ACTIVITIES (D22,D27) ENVIRONMENTAL MONITORING (D22) REVIEWS OF -DESIGNS -PROPOSALS -PLANS (D8,D9,D10)	INSPECTION REPORTS AND FORMS MONITORING REPORTS, MEMOS DATA SHEETS REVIEW REPORTS	
	ES&H COMMITTEE (A2, B4)	INSPECTION ACTIVITIES (PERIPHERAL PURPOSE) (D4,D27) SOLICITATION OF INPUTS -DIRECTLY -ES&H MEETING (C4) PLAN UPDATE (D1, D2, D4) DISSEMINATE ES&H STAFF HAZARD IDENTIFICATION INFORMATION (D6)	INSPECTION REPORTS AND FORMS FORMS, COMMITTEE NOTES MEETING MINUTES PLAN (D3, D3) COMMITTEE NOTES AND MEMOS MEETING MINUTES	
	LINE MANAGEMENT (LARGELY DEFINITION OF PROGRAM FOR MEETING CRITERIA, AND SUPPORT FOR DOING SO)	DIRECT DEVELOPMENT OF PLAN (A1, D3) PROVIDE FUNDS AND PERSONNEL (A2, A3, A4) ARRANGE FOR NEPA ACTIONS	DIRECTIVES, PLAN BUDGETS PERSONNEL ASSIGNMENTS EA, EIS OR PLAN	

Figure 2. Administrative Approach to Assuring That Significant Hazards Are Identified

CRITERION	RESPONSIBILITY (B1)	FUNCTION (B3)	EVIDENCE (C1, D19, D28)	INTERNAL ASSURANCE
DEFINE ACCEPTABLE CONTROLS	FIRST LINE SUPERVISOR	ANALYSIS AND PLAN INPUTS (D3, D5, D6, D7, D11-D22)	ES&H PLAN, RELATED MEMOS, SOPS, JTAS, QA PROGRAM, CALIBRATION PROGRAM, TEST PROGRAM, ETC. (C3, C5)	*FIRST CONCERN: PLAN REALLY BEING FOLLOWED (E9) *SECOND CONCERN: PLAN LEADS TO DESIRED RESULTS (IN THIS CASE, THE DEVELOPMENT OF ACCEPTABLE CONTROLS) (E9) VERIFIED THROUGH AUDIT (E6) ACTIVITIES BASED ON *OBSERVATION - I.E., INSPECTION ACTIVITIES (E2, E3, E4, E5, E7) *REVIEWS OF EVIDENCE (E1, E2, E3,) *INTERVIEWS (E2, E7) USING LINE CONTROL PROGRAM ELEMENTS AS BASE. EVIDENCE: *AUDIT PLAN SHEETS AND ANY SUBSIDIARY MATERIAL GENERATED DURING AUDIT. *AUDIT REPORT (E9)
		ARRANGE SPECIALIST INPUTS (B5, D3)	MEMOS	
		DESIGN ACTIVITIES (D3)	DESIGNS, BLUEPRINTS	
		QUALIFICATION OF EQUIPMENT (D14, D22)	INSPECTION AND TEST RESULTS	
		DESIGN, PROCEDURE REVIEWS (D5, D9, D10, D21)	REVIEW REPORTS	
		DESIGN VERIFICATION TESTS (D11)	TEST RESULTS	
		TRAINING/ QUALIFICATION PROGRAM (D23, D24)	TRAINING RECORDS	
		ENVIRONMENTAL MONITORING (C5)	ENVIRONMENTAL MEASUREMENT RECORDS	
		DEVELOPMENT OF PROCEDURES AND OTHER CONTROLS, INITIALLY, OR AS CORRECTIVE ACTION (B3, C5, D20, D21, D26, D27, D29)	PLAN AND REFERENCES, AS ABOVE	
	PERSONNEL (C4)	INPUTS TO PLAN AS REQUESTED (D3, D27)	MEMOS, NOTES MEETING MINUTES	
		DESIGN ACTIVITIES (D3)	DESIGNS, BLUEPRINTS	
		PARTICIPATION IN ES&H MEETINGS (D3, D27)	MEETING MINUTES AND ATTENDANT FORMS	
		REVIEW ACTIVITIES (D5, D9, D10, D11,)	REVIEW REPORTS	
		PARTICIPATION IN ANALYSES AND CONTROL DEVELOPMENT, AS ASSIGNED (D3, D5, D6, D7, D11-D22)	PLAN, REPORTS, MEMOS, RECORDS	
		FORMAL AND INFORMAL REPORTS ON CHANGE (D27)	FORMS, SUPERVISORY AND COMMITTEE NOTES	
	SPECIALISTS (AS REQUESTED, INCLUDING ES&H STAFF, CONSULTANTS, AND PERSONNEL FROM QA/QC, RELIABILITY AND HUMAN FACTORS, SYSTEMS SAFETY, STANDARDS AND CALIBRATION, MATERIAL TESTING, AND TRAINING DEPARTMENTS) (B2, B5, B6)	REVIEW ACTIVITIES -DESIGNS -PROCEDURES (D5, D9, D10, D11)	REVIEW REPORTS, MEMOS	
		INSPECTIONS (D20, D22, D27)	INSPECTION MEMOS	
		ANALYSIS ACTIVITIES (AS ABOVE)	REPORTS, MEMOS	
		DESIGN ACTIVITIES (D3)	DESIGNS, BLUEPRINTS, REPORTS	
	ES&H COMMITTEE (A2, B4)	SOLICIT PERSONNEL INPUTS -DIRECTLY -ES&H MEETING (C4)	FORMS, COMMITTEE NOTES, MEETING MINUTES	
		PROVIDE ASSISTANCE -DIRECTLY -TRANSMITTAL OF STAFF GUIDANCE (C2, D3, D6,)	MEMOS, GUIDANCE DOCUMENT LOGS	
		PROVIDE TRAINING RECOMMENDATIONS (D23, D24)	TRAINING RECORDS, MEMOS (D26)	
	LINE MANAGEMENT (LARGELY DEFINITION OF PROGRAM FOR MEETING CRITERIA, AND SUPPORT FOR BEING SO)	DIRECT DEVELOPMENT OF, AND REVIEW, PLAN (A4) (A1, C2)	DIRECTIVES, PLAN AND SIGNATURES	
		POLICY OF RISK VERSUS CONTROL	DIRECTIVES	
		PROVIDE FUNDS AND PERSONNEL (A2, A3)	BUDGETS, AND PERSONNEL RECORDS	
		ARRANGE FOR NEPA ACTIONS	EA, EIS	

Figure 3. Administrative Framework in Which Acceptable Controls over Recognized Hazards Are Defined

CRITERION	RESPONSIBILITY (B1)	FUNCTION (B3)	EVIDENCE (C1, D19, D28)	INTERNAL ASSURANCE
USE CONTROLS	FIRST LINE SUPERVISOR	PROVIDE DEFINITION OF CONTROLS TO PERSONNEL (D7)	PLAN, PROCEDURES, DIRECTIVES, ESAH MEETING MINUTES, MEMOS	
		SOLICIT SPECIALIST INPUT (B5)	MEMOS	
		INSPECTION/MONITORING OF OPERATIONS, FACILITIES, EQUIPMENT AND DOCUMENTS (D8, D9, D10, D27)	INSPECTION FORMS, REPORTS AND MONITORING REPORTS	
		PROVIDE DIRECT CONTROLS (D11, D15, D21)	DOCUMENT SIGNATURES APPROVALS, AND AUTHORIZATIONS	* FIRST CONCERN: PLAN REALLY FOLLOWED (E9)
		OPERATE JOB PLACEMENT/ SPECIFICATION SYSTEM (D23)	PERSONNEL RECORDS, DIRECTIVES	* SECOND CONCERN: PLAN LEADS TO DESIRED RESULTS (IN THIS CASE, THE USE OF CONTROLS) (E9)
		AUTHORIZE AND/OR PROVIDE TRAINING AS REQUIRED (D23, D24)	TRAINING REGISTRS (D22), MEMOS	
		EXECUTE PERIODIC CONTROL TESTS	TEST RECORDS	
	PERSONNEL (C4)	USE CONTROLS	LOGS, RECORDS, REPORTS AND SIGNATURES	
		POST OR MAINTAIN APPROPRIATE CONTROL DOCUMENTS (D26, D28)	SUPERVISORY INSPECTION REPORTS AND FORMS	
		PARTICIPATE IN DISCUSSION OF CONTROLS, THEIR USE AND CHANGES (D27)	ESAH MEETING MINUTES SUPERVISORY LOGS	
	SPECIALISTS (AS REQUESTED, INCLUDING ESAH STAFF, CONSULTANTS, AND PERSONNEL FROM QA/QC, RELIABILITY AND HUMAN FACTORS, SYSTEMS SAFETY, STANDARDS AND CALIBRATION, MATERIAL TESTING, AND TRAINING DEPARTMENTS) (B2, B5, B6)	HUMAN FACTORS, AND OTHER ANALYSES, TO EXAMINE RELIABILITY OF CONTROL USE (D7)	REVIEW REPORTS, MEMOS, DESIGN DOCUMENTS, MEETING MINUTES	VERIFIED THROUGH AUDIT (E8) ACTIVITIES BASED ON * OBSERVATION - I.E., INSPECTION ACTIVITIES (E2, E3, E4, E6, E7) * REVIEWS OF EVIDENCE (E1, E2, E3) * INTERVIEWS (E2, E7) USING LINE CONTROL PROGRAM ELEMENTS AS BASE. EVIDENCE: *AUDIT PLAN SHEETS AND ANY SUBSIDIARY MATERIAL GENERATED DURING AUDIT. *AUDIT REPORT (E9)
	ESAH COMMITTEE (A2, B4)	CONTROL INFORMATION PROVISION THROUGH PLAN, ESAH MEETINGS, AND DISSEMINATION OF STAFF GUIDANCE (D8, D27)	PLAN, MEETING MINUTES	
		INSPECTION (PERIPHERAL PURPOSE) (E2)	INSPECTION FORMS AND REPORTS	
		PROVIDE TRAINING RECOMMENDATIONS (D23, D24)	TRAINING RECORDS, MEMOS	
	LINE MANAGEMENT (LARGELY DEFINITION OF PROGRAM FOR MEETING CRITERIA, AND SUPPORT FOR DOING SO) (A4)	PROVIDE FUNDS, PERSONNEL, AND POLICY (A1, A2, A3)	BUDGETS, PERSONNEL RECORDS AND ASSIGNMENTS	
		REVIEW, OR ARRANGE FOR REVIEW, OF PLAN FROM PERSPECTIVE OF CLEAR DEFINITION OF CONTROLS (D7)	MEMOS, REVIEW RECORDS OR REPORTS	
		REQUIRE PERIODIC STATUS REPORTS (D7)	STATUS REPORTS, DIRECTIVES	
		VISIBLY USE PERFORMANCE IN MERIT AND PROMOTION DECISIONS (D23)	PERSONNEL RECORDS	

Figure 4. Administrative Approach to Assuring That Defined, Acceptable Controls Are Consistently Used

ES&H meetings for the Department shall be arranged for and conducted by the ES&H Committee. One meeting is to be held each year for the complete Department, and two meetings each year are to be conducted for each Division. Minutes of these meetings will be maintained in the Departmental ES&H records (see below). Personnel who cannot attend these meetings shall review the meeting minutes and submit written comments on the meeting topics.

In accordance with requirements in the ES&H Staff document, "Guidelines for Line Organization ES&H Meetings," the following items are to be part of the agenda for each Division ES&H meeting:

- *Committee presentation of area inspection results,*
- *Presentation and discussion of accidents that have occurred,*
- *Discussion of hazards identified in ES&H activities and mitigating actions previously initiated, and*
- *Determination of a consensus for improved mitigating actions and corrective actions. All recommendations for actions will be forwarded to the Department Manager.*

The ES&H Committee shall maintain and document liaison with the ES&H Staff organization. The liaison shall include

- *Obtaining results of analyses performed by the Staff organization that are applicable to the Department,*
- *Obtaining guidance for all ES&H activities,*
- *Arranging for training of Department personnel, as necessary,*
- *Obtaining review of the Departmental ES&H plan: once every 2 years; otherwise, whenever significant changes occur in Department activities and plans, and*
- *Providing recommendations developed through Departmental ES&H activities to the Staff organization. Recommendations may be concerned with the total Institutional ES&H program or with specifics such as ES&H training activities.*

All ES&H records shall be maintained by the ES&H Committee. These records consist of this Department's ES&H plan (including the appendices) and the records that will be titled "Department ES&H Records for the Calendar Year 19XX," which include

- *ES&H Committee membership records,*
- *ES&H training records (including those for Committee members),*
- *ES&H meeting records, including records of inputs from individual employees,*

- *An up-to-date list of specialists used by the Committee, supervision, or Department management, their qualifications, and what they are used for,*
- *Inspection, audit, and review reports, both those performed within the Department and those performed by organizations external to the Department, including specific criteria used,*
- *Program evaluations, both those performed by the Committee and those performed by others,*
- *ES&H analysis reports, notes, and so forth, as appropriate,*
- *Hazardous condition reports submitted by supervision or personnel, the associated corrective action reports, and the Departmental response thereto,*
- *Accident reports prepared by supervision or restricted-scale or full-scale accident investigation teams, and appropriate evidence of corrective action, if needed,*
- *Control activity procedures and reports, including special or continuous-operation permits,*
- *ES&H requirements and ES&H guidance, as furnished by the ES&H Staff organization,*
- *All quality assurance (QA) records pertinent to material or equipment involving significant hazards or their control, and*
- *Records of all ES&H-related activities pertinent to the organization, both internally and externally originated, not covered above.*

The Committee shall perform the following assurance functions (per the requirements in the ES&H Staff documents, "Guidelines for Line Organization ES&H Audits and Appraisals," "Guidelines for Line Organization ES&H Review Activities," and "Guidelines for Line Organization ES&H Inspection and Monitoring Activities"):

- *Semiannual inspections of facilities and projects, in order to identify new hazards and any changes in factors affecting risk, using the Institutional Inspection Form provided by the ES&H Staff.*
- *Selective reviews of ES&H-related documents as required in "Guidelines for Line Organization ES&H Review Activities."*
- *Audits of ES&H activities in the Department, using the Audit/Appraisal guideline cited above. These audits are to be conducted semiannually, and the documented audit results are used as input data for the evaluations conducted by the ES&H Staff.*

Elements audited are given in Appendix A. Specific criteria used are to be filed with audit reports.

- *Provision of assistance for external agencies in the conduct of audits of the Departmental ES&H program.*

The ES&H Committee shall prepare semiannual reports on the status of the Departmental ES&H program, based on the results of inspections, audits, and reviews, and submit these reports to the Department Manager.

Department activities in the Institutional Emergency Response Program shall be coordinated by the ES&H Committee. See Appendix C for this Department's Emergency Response Plan.

The Committee shall develop and maintain a list of specialists for use by itself, supervisors, and Department management.

Supervision

Supervision shall, with guidance from the ES&H Committee and the ES&H Staff and with the assistance of Department personnel, identify the hazards in their operations, perform (or arrange for the performance of) appropriate analyses of these hazards, and establish acceptable controls for these hazards. Effort expended in analysis and in control establishment activities should be scaled to the risk presented by each hazard. Analyses are performed in accordance with requirements in "Guidelines for ES&H Analysis Activities," issued by the ES&H Staff. The control measures established shall include

- *Consideration of ES&H in all planning activities,*
- *Consideration of ES&H in budget, schedule, and design reviews (per the requirements in the ES&H Staff document, "Guidelines for Line Organization ES&H Review Activities"),*
- *Control of all program changes (including design changes, budget and schedule changes, operational or personnel changes, and procedure changes) in the same manner as the initial program elements are controlled,*
- *Verification of ES&H-related features of design through analyses, reviews, or tests (per the requirements of "Guidelines for utilizing Quality Assurance Support in ES&H Assurance Programs"),*
- *Monitoring of budgets, schedules, designs, purchase requisitions, etc., and inspection of operations, equipment, and facilities to identify changes,*

- *Control and monitoring of equipment and environmental conditions (per the requirements in "Guidelines for Line Organization ES&H Inspection and Monitoring Activities"), and*
- *Enforcement of the use of approved procedures, plans, and so forth.*

All control activities shall be documented and reported to the Department Manager. The controls shall be periodically reviewed (at least quarterly) and evaluated. Where quality of facilities or equipment is a factor in controlling the risk involved in a hazard, the controls are those specified in the Departmental QA Plan. A calibration and maintenance program has been established for ES&H-related instruments, as described in the Departmental QA Plan.

Supervisors shall identify and investigate conditions detrimental to ES&H, determine the causes of such conditions, initiate corrective action, and verify corrective action. Such actions shall be documented and may involve the assistance of the ES&H Committee, as appropriate.

The supervisors and/or Division personnel shall report accidents and hazardous conditions to supervision and/or the ES&H Committee, as appropriate. Supervision shall, when directed by the ES&H Staff organization, initiate the investigation of accidents and implement and report corrective action, when appropriate. Policy specified in the ES&H Staff "Plan for Institutional Accident Investgations" is to be followed.

The supervisor shall familiarize Division personnel with this ES&H plan and establish measures assuring implementation of the plan in the Division. The Division supervisor shall also make Division personnel available for training in preparation for serving on the ES&H Committee, or as otherwise required.

Department

Department ES&H activities shall be scheduled, to the extent possible, in accordance with Figure 5.

The Program Requirements section is the heart of the administrative portion of the plan, specifying how each of the ES&H functions of the organization is to be performed. The summary in *Figures 2, 3,* and *4*

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Department		AUDIT		SR	I_O		REVIEW	AUDIT		SR	I_O	M
Div. A	I	M					I	M				
Div. B		I_L	M					I_L	M			
Div. C		I_L	M					I_L	M			
Div. D				I_L	M					I_L	M	
Div. E				I_L	M					I_L	M	
Div. F	I_L	M					I_L	M				
ES&H Committee			S	T			S	T			S	T

I - Inspection ($I = I_O + I_L$)

I_O - Office Area Inspection

I_L - Lab Area Inspection (includes storage areas)

M - ES&H Meeting

S - Selection of New Committee Member

T - Training of New Committee Member

SR - Status Report

Figure 5. Departmental ES&H Activity Schedule

should be made more explicit in this section of the plan. ES&H functions may be categorized as control, assurance, and support functions. As noted under Assigned Responsibilities, the control function is largely the responsibility of management (supervision), the assurance function is assigned to an independent group such as the ES&H Committee, and the support function is generally a shared function. The directive function of management and the participative function of personnel are not as specifically addressed in this section of the model plan, but the importance of these functions should again be stressed and reference made to them in summary figures.

Figures 2, 3, and *4* in this model are rather unique--presenting in simple overview the essence of an entire management system as seen from the perspective of a working level Line organization. Several things may be learned from these figures when considered in conjunction with the model text:

- An ES&H administrative plan need not be excessively lengthy or complex,

- The program elements defined by the ES&H Assurance Standard[1,3] support the basic criteria in multiple ways,
- Failure to satisfy a criterion involves "subfailures" on the part of many different individuals, and
- There are relatively few basic documents and forms involved in the performance of an ES&H program, as indicated by the "Evidence" columns of *Figures 2, 3,* and *4*.

It is easy to conjure up extreme concerns about documentation in conjunction with "assurance." *Figures 2, 3,* and *4* in the model should begin to allay "paperwork" fears. Most of the documentation cited in these figures is not unlike documentation that routinely exists in "safety" programs today. The structure of some of this is rather different (References 2 through 15) but, we believe, no more difficult or time-consuming. Novel features, however, do exist and include

- ES&H plans,
- Reviews, and
- Audits.

For many ES&H programs today, the major difference between ES&H plans and current documentation is the administrative section of the plan. Such things as safe operating procedures (SOPs), safety analyses (SAs), and job task analyses (JTAs) are akin to the appendices of this document. To the extent that SOPs, SAs, JTAs, and so forth, are reviewed, requirements for the reviews of plans and documents are no novelty--the use of review criteria [4,12] might be.

APPENDIX A

*ES&H Audit Checklist for Departmental Audits**

Area	*Program Elements*
A. Management Support	*1. Departmental policy statement* *2. ES&H Committee defined* *3. Adequate funding for ES&H program* *4. Management involvement*
B. Organization	*1. Assignment of responsibility and authority* *2. Established lines of communication* *3. ES&H functions in Department* *4. Independence of ES&H assurance functions* *5. Use of specialists in ES&H program* *6. Provision for collaboration between organizations on ES&H matters*
C. Program	*1. Documentation of Departmental ES&H Assurance Program* *2. Provision for varying ES&H controls in accordance with degree of risk* *3. Departmental ES&H assurance plan* *4. Provision for participation by personnel in Departmental ES&H functions* *5. Provision of controls over equipment and environment.*
D. Departmental ES&H Control Functions	*1. Provision of facility/project information* *2. Classification of facilities/projects by ES&H categories* *3. ES&H considerations in planning* *4. Maintenance of hazard list* *5. Documentation of risk assessments* *6. Correlation of requirements with hazards* *7. Reporting of ES&H control activities* *8. Budget proposal reviews* *9. Schedule proposal reviews* *10. Design reviews* *11. Design verification controls* *13. Calibration program* *13. Maintenance program* *14. Qualification of equipment* *15. Storage and handling controls*

*Criteria and plans for auditing these program elements are those given in the ES&H Staff document, "Guidelines for Line Organization ES&H Audits and Appraisals."

Area	Program Elements
D. Departmental ES&H Control Functions (continued)	16. Material and equipment identification
	17. Status identification of material and equipment
	18. Provision of fabrication process procedures
	19. Quality documentation
	20. Quality corrective action program
	21. Procurement controls
	22. Test and inspection program
	23. Qualification and training for job assignment
	24. ES&H training
	25. Maintenance of training records
	26. Written operating procedures
	27. Change control
	28. Record storage and retrieval
	29. ES&H corrective action program
E. Departmental ES&H Assurance Functions	1. Review of ES&H assurance plan
	2. Verification of control and control change implementation
	3. Monitoring for new hazards
	4. Monitoring of risk factors and controls
	5. Monitoring of environmental conditions in work areas
	6. Provision of audit program
	7. Verification of corrective action
	8. Evaluation through record reviews
	9. Evaluation of monitoring and audit data

Appendix B

Departmental ES&H Analysis

This appendix is composed of five sections that discuss and/or present the following:

I. Facility/Project List
II. Hazard Source List
III. Hazard Analysis, Mitigation Measures, and Controls
1.0 High-Pressure System
2.0 Environmental Test Chamber
3.0 Electronic Equipment
4.0 Chemicals
5.0 Machine Tools
IV. References

I. Facility/Project List

This section identifies those areas for which this Department is responsible, briefly describes the nature of the activities in each, and identifies the responsible supervisor.

1. *High-Pressure Test Facility*
   Remote Area, Building 18
   The high-pressure test facility is located in a steel-plated, barricaded room in Building 18. The facility is used for tests and experiments with various types of high-pressure hardware.
   Supervisor: Harry Black.
2. *Environmental Test Chamber*
   Building 10, Rooms 103 and 105
   Room 105 is a staging laboratory for preparing samples for environmental tests. Room 103 consists of a walk-in environmental test chamber, capable of providing environments of extreme high and low temperatures. Supervisor: Penny Wilson.
3. *Electronic Laboratories*
   Building 10, Rooms 106 and 107

These laboratories include the electronic test equipment typical of such laboratories. Open setup activities are common. Supervisor: John Hernandez.

4. *Chemical Laboratories*
   Building 10, Rooms 102 and 104
   These laboratories are used for the performance of chemical tests involving the handling of corrosive and toxic chemicals. Supervisor: Andy Elton.
5. *Machine Shop*
   Building 10, Rooms 109 and 111
   Machinery used in this shop is typical of a small machine shop. Shops in other Departments are available for heavy machine work. Supervisor: Jay Sorenson.
6. *Storage Areas*
   Building 10, Rooms 108 and 110
   These areas are used only for temporary storage of test materials and test units. Stored items may include flammables, corrosives, and toxic substances. Supervisor: Jan Porter.
7. *Staff Offices*
   Building 10, Rooms 101 and 201 through 213
   Staff offices are furnished with desks, files, and other office furniture. Hazards are generally limited to those associated with tripping or falling.

II. Hazard Source List

This section lists the generic sources of significant hazards for the Departmental areas just described. The generic types of impact that might occur are identified, and the hazard sources are associated both with the facility/project in which they reside and the section, below, in which each hazard is analyzed.

	Facility/Project (see Section I)	*Analysis, Mitigation, and Control*
1. *High-Pressure System*	1	1.0
(a) *Impact by high-energy projectiles, lines, or gas jets*		
2. *Environmental Test Chamber*	2	2.0
(a) *Cryogenic or high-temperature burns*		

3.	*Electronic Equipment*	3, 6	3.0
	(a) Electrical Shock		
4.	*Chemicals*	4, 6	4.0
	(a) Burns		
	(b) Illness induced by toxicity		
5.	*Machine Tools*	5	5.0
	(a) Laceration, abrasion, and so forth, from kinetic energy		

III. Hazard Analysis, Mitigation Measures, and Controls

This section presents the analysis of Departmental hazards, aggregated in accordance with the categories of Section II, just above.

*1.0 High-Pressure System**

1.1 System Description

The High-Pressure Test Facility is located in the Remote Area, 1.5 km (1 mile) from any residential area and 0.38 km (0.25 mile) from any office building. The facility is a 93-m^2 (1,000-ft^2) building with the pressure vessel and testing area located in the southeast corner (see Figure B1). The control booth from which all tests are conducted is located near the center of the room.

The high-pressure facility is capable of producing pressures up to 82,800 kPa (12,000 psig) for a number of different types of tests and experiments on high-pressure hardware. Three types of bottled gas are used for testing: helium, argon, and nitrogen. The bottled gas, at 14,490 to 15,180 kPa (2,100 to 2,200 psig), is directed into a Haskel two-stage pump, which is driven by house air at 1,035 kPa (150 psig). The action of the pump is to compress the bottled gas to the desired pressure for testing purposes up to the system capability of 82,800 kPa (12,000 psig). Normally, the system is operated at less than this pressure.

A schematic of the pressure system is shown in Figure B2. The Maximum Allowable Working Pressure (MAWP) for the system is 82,800 kPa

*Material in this section has been modified from Appendix A of Reference 23.

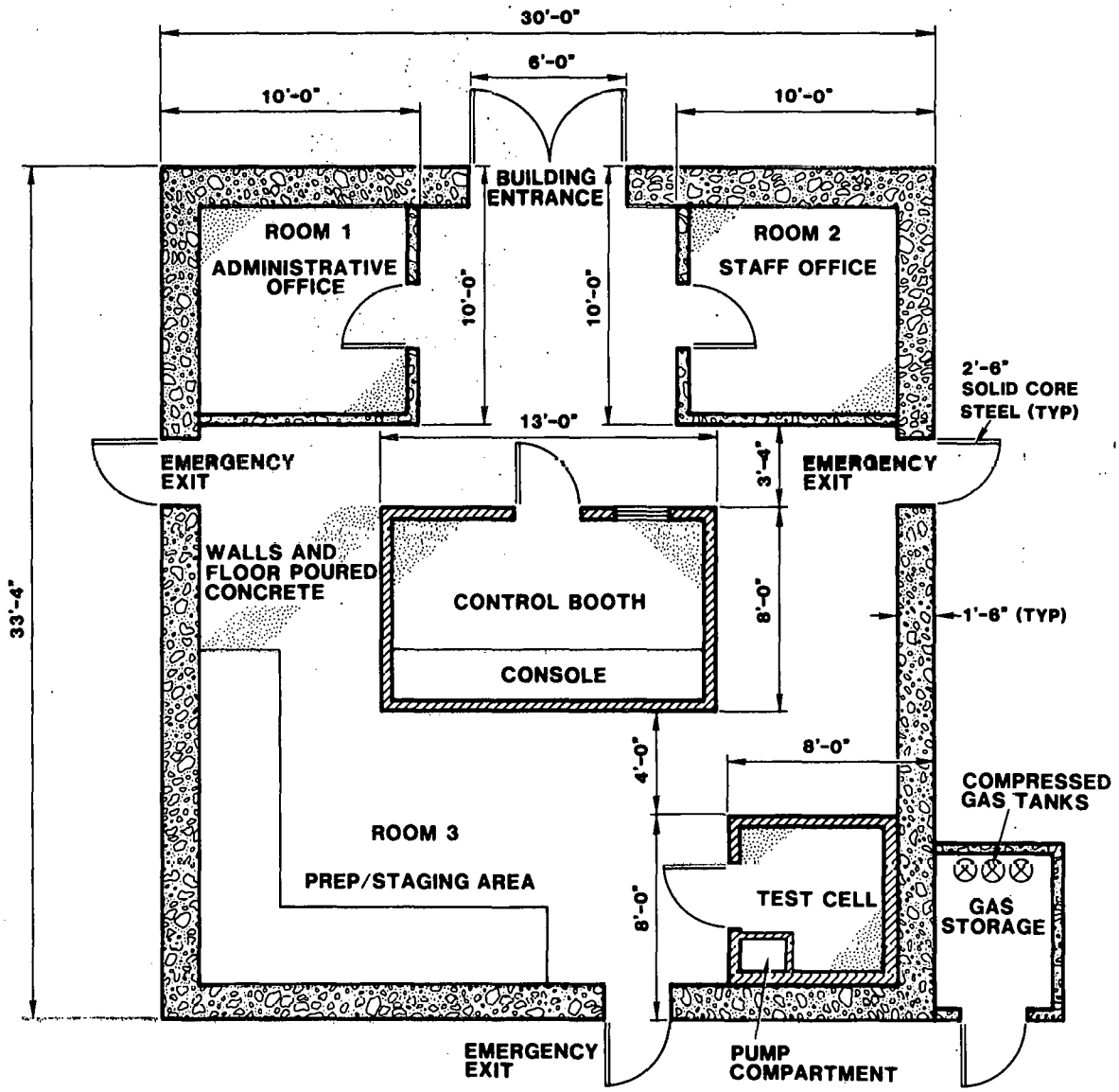


Figure B1. High-Pressure Test Facility

(12,000 psig), which is based on the weakest link in the system, which is the 1,000-cm^3-volume pressure vessel, rated at 12,000 MAWP. Note that the 138-MPa (20,000-psig) Haskel pump has a capability that exceeds the MAWP of the 1,000-cm^3 volume by 55,200 kPa (8,000 psig).

1.2 Hazards and Potential Consequences

The hazard identification process, carried out in accordance with, and using the categorization criteria of, Reference 1, has identified this pressure system as an "unusual" hazard of the "kinetic energy"

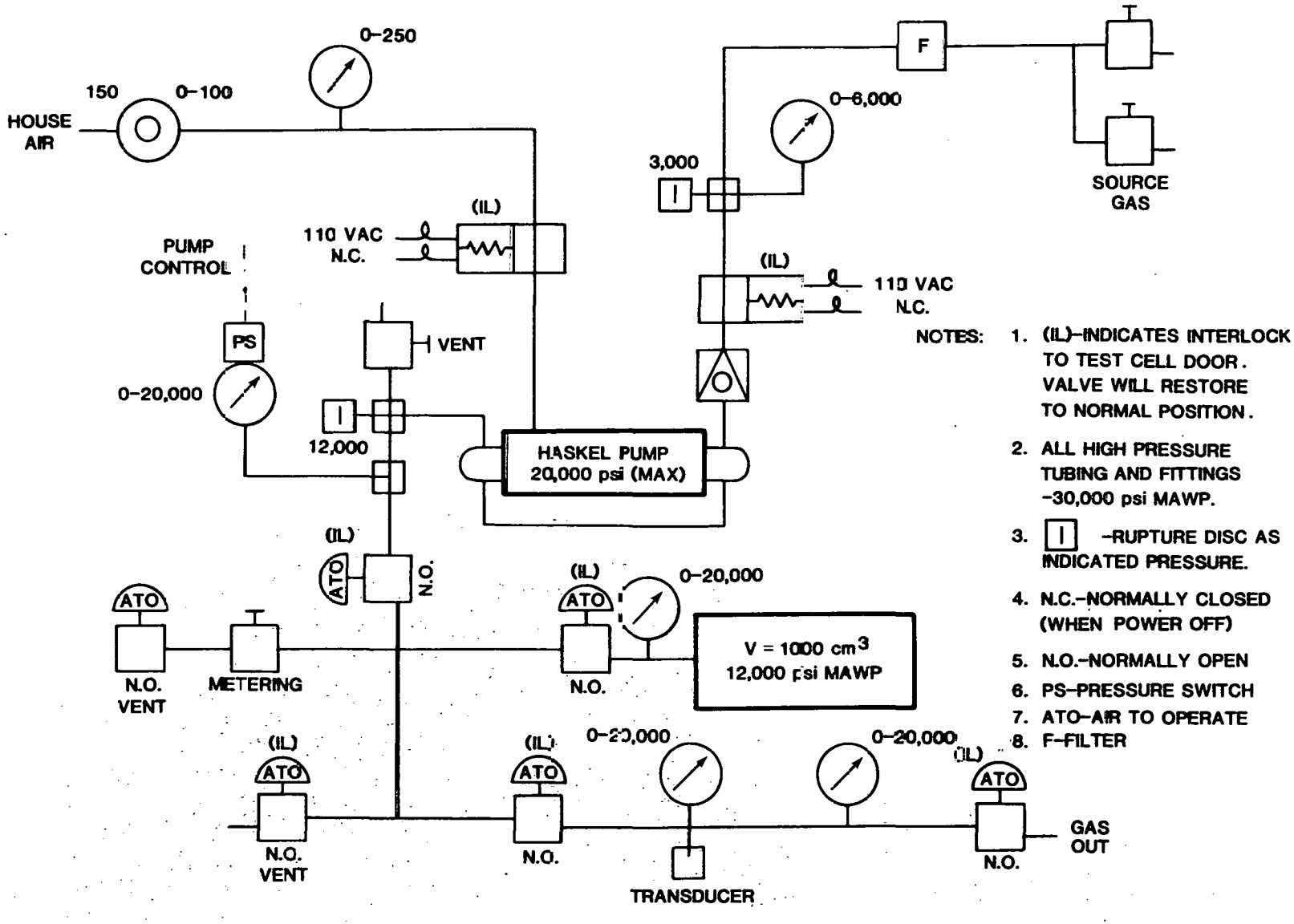


Figure 32. Pressure System Schematic

type--specifically, a high-energy pressure system. In addition, the system presents a hazard of the "nutrient deprivation" type (presenting a possibility of anoxia in the test cell), which is controlled by those access procedures (see below) designed to protect against injury from the potential impacts of the kinetic energy hazard. All electrical voltages are 220 volts or less and judged to be routine. The system presents a hazard only to personnel safety, being judged on the basis of its location and nature to present essentially no risk to the public, the environment, or the health of personnel.

1.3 Failure Events, Consequences, and Risk Factors

The major generic events to be avoided and/or protected against are personnel exposure to these hazards and high-energy release due to system failure. A breakdown of the generic events associated with high-energy release is shown in Figure B3. Here, "Barrier Failures" include failure of physical barriers, failure of interlock systems, failure of warning systems, failure of automatic shutdown systems, and failure of procedures, all of which are controls (described below) over personnel exposure.

1.4 Controls

Based on past experience with similar systems, two levels of controls have been established: controls over subsystem failure and controls over personnel exposure. In each instance, both design and operational controls are used.

The following are the steps taken to control system failure:

1. *The pressure vessel is designed and manufactured in accordance with applicable American Society of Mechanical Engineers (ASME) specifications and has a safety factor of 4.*[2]
2. *All lines, fittings, and (nonrelief) valves are rated, by actual test, at 207 MPa (30,000 psi) with a safety factor of 4.*
3. *Gauges were selected to operate at approximately one-half scale and have solid-front design, full blow-out backs (with standoffs), and plastic faces.*
4. *The system is designed so that either power shutdown by switch at the main panel or a power loss, which would lead to loss of house-air-actuated controls, will cause the system to automatically vent, the pump to stop, and gas flow to the pump to stop. System flow capacity is greater than pump output by a factor of more than 10:1.*

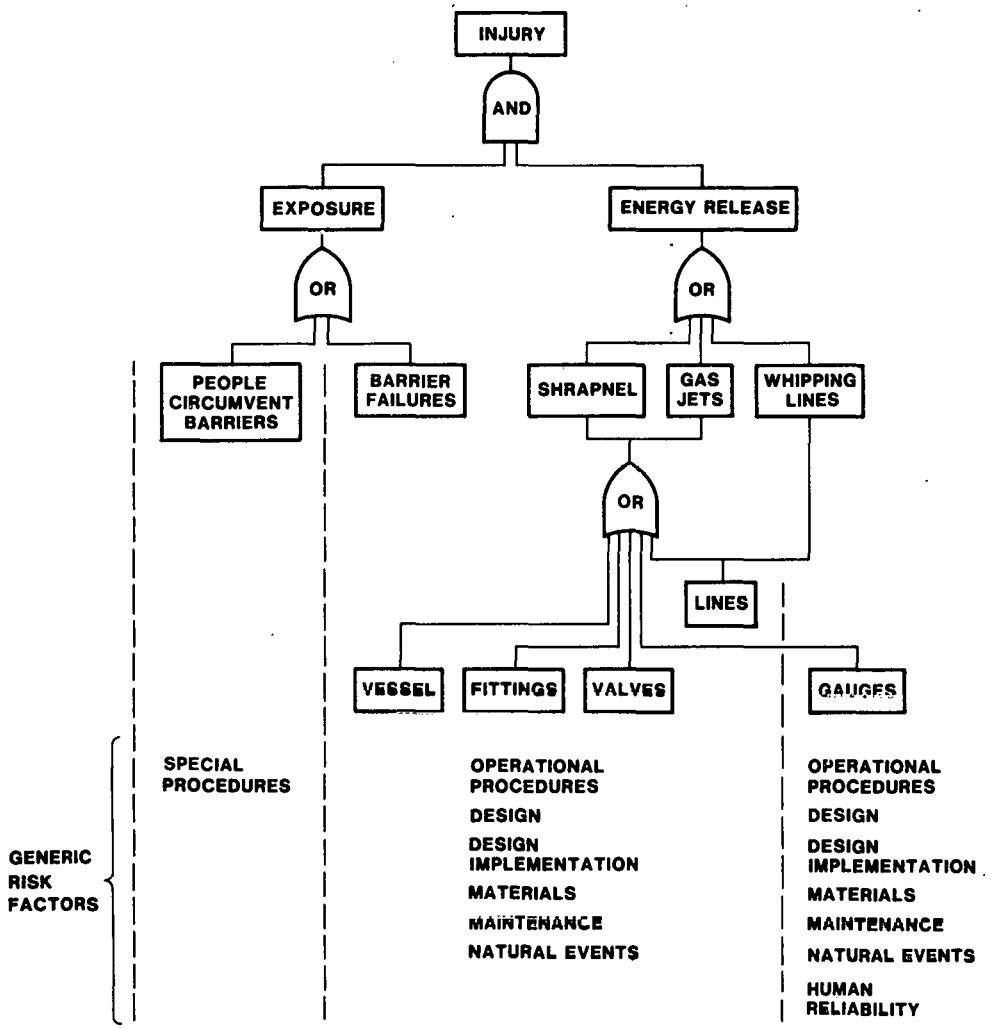


Figure B3. Event Analysis

5. *All operators must achieve the highest level of certification in Pressure System Certification Training (described below) as well as serve a 6-month probationary period.*
6. *Kellum grips are used on all lines and fittings to prevent any whipping lines.*
7. *A rupture disc at MAWP is in series with the Haskel pump output, and a rupture disc rated at 20,700 kPa (3,000 psig) is between the bottled gas and the automatic shutoff valve near the pump input.*
8. *A minimum of two qualified operators will be present during any high-pressure pumping operation.*
9. *No gas shall be introduced into the system until all valves are placed in their proper open or closed position, as*

indicated by the control panel lights and verified by at least two operators. A checklist is used, signed, and filed for each test.

10. *A detailed "Operating Checklist for the High-Pressure Test Facility" has been prepared and is in use.[3,4] It covers*
    - *Pretest checks,*
    - *Pumping operation,*
    - *Daily door interlock tests,*
    - *Static receiver pressurization,*
    - *System purge, and*
    - *Posttest checks.*
11. *ES&H inspection and test activities are performed as specified in Reference 5. In particular, the interlock system is tested at the beginning of each operational period.*

Lastly, electrical hazards that might be inadvertently encountered are located only in the control console. These are controlled by a keylock on the console door and by an interlock that shuts off power to the console when the console door is open.

The following controls are used to limit the likelihood that personnel will be exposed in the event of a system failure:

1. *Inadvertent access by personnel is first controlled by an interlock on the cell door. Opening the interlock will stop the pump, shut off the gas to the pump, and vent the system. Visual observation of the only path of access to Room 3 and the test cell is maintained from the control booth by an operator after Room 3 and the test cell are cleared (see 4., below).*
2. *The operator booth is a self-contained unit with no port or access on the side toward the testing area. All tests are remotely controlled and are observed via camera.*
3. *Flashing warning lights at the test cell and at all building entrances are on when the system is on, and warning signs are placed with each light.*
4. *No gas is introduced into the system until the cell has been cleared, the cell door closed, and Room 3 (Figure B1) cleared. Closing the cell door closes the interlock and starts the flashing warning lights.*
5. *The Haskel pumping system is located inside a 1/4-inch-steel-plate compartment, and this compartment is located inside the high-pressure test cell, as shown in Figure B1. The cell*

itself consists of 1/4-inch-steel-plate walls backed by 1-1/2 inches of plywood. The test cell, pump compartment, and console are all used as barricades to protect the operators from exposure to shrapnel, whipping lines, and gas jets should an accidental rupture occur.

6. ES&H inspection activities[5] also limit the likelihood of exposure.

All electrical repairs and measurements within the control console are made by the Maintenance Department under the direction of the supervisor of the High-Pressure Test Facility.

These controls have been reviewed and accepted by all involved personnel, as required by the Institutional ES&H Program.[6]

1.5 ES&H Management

The test facility is operated by a crew of operators and a supervisor under the organizational structure described in the administrative portion of this Department's ES&H plan. All experiments are approved by the supervisor and run by trained personnel. Checklists are used during all experiments, and copies are kept in the supervisor's office. Monthly ES&H meetings are held to discuss ES&H topics, experiment problems, and training needs. An ES&H Committee of personnel, trained (Reference 7) to perform internal inspections and audits is appointed by the Department Manager. Routine printouts for maintenance procedures, training updates, and audits are provided by the ES&H Staff to the Committee and to the supervisor. A monthly status report covering the above items is provided to the Department Manager by the supervisor.

Specific administrative controls to assure the use and maintenance of direct hardware and procedural controls include the following:

1. The system design has been reviewed by independent pressure systems, quality, and human factors specialists. The review criteria used are in Reference 8.
2. All equipment is certified and tested by the in-house certification group, using the procedures in References 2 and 9. As a part of this testing, the 1,000-cm^3 (61-in^3) pressure vessel is proof-tested hydrostatically at least once every 5 years to 1-1/2 times MAWP. ASME certifications are on file with the cognizant supervisor (Division A). Also, rupture discs are certified by manufacturing data.

3. A maintenance program with automatic recall at 6-month intervals is used for all pressure relief valves in the system.[2,9]

4. High-level certification involves completion of the material in the Pressure Safety Practices Course,[10] the Pressure Advisor Safety Course[11], and the Pressure Technician Safety Course.[12]

Emergency response is carried out in accordance with the Institutional plan[13] (as specified in Appendix C)--a trained[14] response team is led by an emergency chief, who in this case is the supervisor of the facility, or his alternate. (See Appendix C).

Personnel exposure to an anoxic environment can occur only to a person in the pressure test cell during a system failure--which in this case need be only a leak of inert test gas. The controls described above to prevent presence in the test cell during a test, coupled with controls designed to prevent system failures, are judged acceptable from the point of view of protecting personnel from anoxic environments.

1.6 Risk Statement

The basic system of the High-Pressure Test Facility is designed and maintained to ASME specifications and in-house pressure safety requirements to greatly limit the likelihood of system failure. These actions are assured by personnel, supervision, and, independently, by an organizational ES&H Committee that reports to Departmental management. In addition, personnel are protected against the energy release subevents (shrapnel, gas jets, and whipping high-pressure lines) should the system fail--to provide an additional level of confidence. It is judged that the system presents a very low risk to employees under these conditions.

This is an example of an ES&H analysis that

- Is relatively simple,
- Follows the guidance given in Reference 10,
- Relies on an integrated institutional program (through references), and
- Would generally rate highly based on review criteria of Reference 12 when combined with the ES&H Administrative plan in the body of this document.

While the administrative plan addresses such things as administrative controls in a general, programmatic way, the ES&H Management Section of the analysis is more explicit about the nature of administrative controls over generic risk factors identified as a part of the analysis.

2.0 Environmental Test Chamber

2.1 System Description

The Environmental Test Chamber is used to test items under controlled conditions of temperature from -160 °F to +670 °F. The chamber size is 10 feet wide by 8 feet high by 12 feet long.

This chamber is used to test the performance of various materials and equipment under extreme temperature conditions. Most of the tests are performed on electronic equipment. Generally, the analysis of the safety of the equipment itself adequately covers its testing in this facility. A separate analysis of the Environmental Test Chamber, per se, is presented here.

2.2 Hazards and Potential Consequences

The primary hazard of concern is temperature--at both high and low extremes. This is of concern from both the points of view of

- Direct contact with surfaces at high or low temperature and
- Working environments of high or low temperature.

The hazard could affect personnel--but is judged to present no credible threat to the public or the environment as defined in Institutional policy.

2.3 Failure Events, Consequences, and Risk Factors

Although several routine hazards are present in the Environmental Test Chamber, the major events of concern are the presence of personnel in the chamber when temperature extremes are reached and inadequate protective equipment is being worn. How these events might occur and upon what risk factors they depend are shown in Figure B4.

Because operations are involved in which personnel are intended to be present in extreme temperature environments, emphasis is placed on

- Understanding the nature of the environment and
- Using appropriate protective equipment.

From Figure B4, the generic events that could involve exposure to extreme temperature under these circumstances are seen to be

- Failure of the temperature control system,
- Failure or inadequacy of protective equipment,

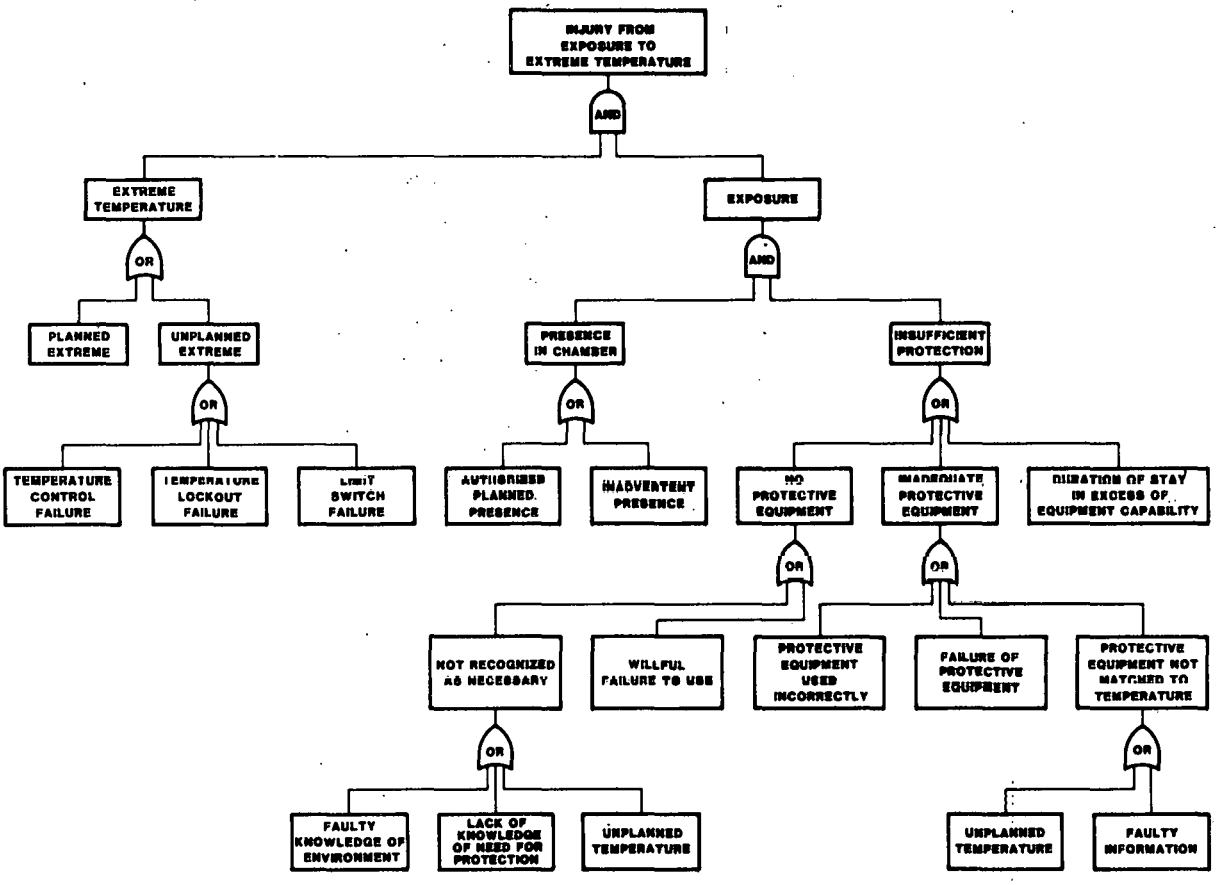


Figure B4. Event Analysis for the Environmental Test Chamber

- *Failure to observe time limits of exposure while using protective equipment,*
- *Failure to recognize the nature of the environment,*
- *Failure to recognize the need for, or to use, protective equipment.*

The generic risk factors, then, are

- *Reliability of temperature control systems,*
- *Reliability of temperature warning systems,*
- *Reliability of protective equipment,*
- *Appropriateness of protective equipment for conditions of required use,*
- *Reliability of devices designed to measure, record, and visually (or otherwise) depict the environment,*

- *Adequacy in training in the need for and use of protective equipment and in procedures for limiting one's stay in extreme environments, as appropriate, and*
- *Reliability of the personnel access control system.*

Controls described in the next section are designed to address each of these generic risk factors.

2.4 Controls

• • •

And So Forth

This document is not intended as a primer either on pressure system safety or extreme temperature environments. Far better documents would be available. The intent of the above model is merely to indicate the types of information one would expect to find in an ES&H analysis associated with significant, unusual[10] hazards. Understanding the ways in which harm might occur and exercising appropriately reliable controls over these failure modes are crucial to the achievement of ES&H objectives. While this is a trite statement, it is also an axiom that is frequently violated.[21] ES&H analyses should be structured so that persons other than those involved in their preparation can judge their adequacy and then subsequently measure the degree to which their conclusions or commitments (in terms of controls) are implemented.

The next two sections of this appendix should be similarly structured.

3.0 Electronic Equipment

• • •

4.0 Chemicals

• • •

The section dealing with machine tools presents a somewhat different story from the perspective of the working level Line organization. Here, the hazards would probably be judged as routine, and thus emphasis would be placed on using standard requirements and/or tailored modifications thereof.[6,10] The outline in the next section briefly illustrates this.

5.0 Machine Operations

5.1 Description of Operations and Hazards

The Machine Shop in Rooms 109 and 111 of Building 10 includes the following numbers and types of machines.

2 Sanders
3 Grinders
2 Drill presses
4 Table saws
1 Lathe (general purpose)

Although heavy machine work is not performed in this Shop, these machines do present a hazard of the kinetic energy type. This hazard is judged to be routine because no unusual size or rotational speed is involved.

5.2 Controls Exercised Over Hazards

• • •

This section should address requirements for guarding machines, maintaining machines, inspecting machines, training of personnel, and so forth. These may be generated

- As mandatory or suggested requirements by governmental agency,
- As mandatory or suggested requirements by the institution's ES&H Staff, and
- As requirements deemed necessary by organizational personnel and management to limit risk to acceptable levels.

The need in this section is for a sufficiently explicit definition of controls so that their adequacy may be judged[4,12] and their degree of implementation measured.[3,11]

5.3 Risk Statement

• • •

This section should emphasize evidence that supports an assertion that risk is acceptable to those at risk.[10]

IV. References

1. *Guidelines for ES&H Analysis Activities, ESH-9, issued by the ES&H Staff. Updated yearly.*

2. *Quality Control Program, QC-12A, issued by the Quality Control Section, with records in Division A supervisor's file. ASME requirements are referenced in, and maintained with, QC-12A.*

3. *"Detailed Safety Operating Procedures for High-Pressure Test Facility," Supervisor's ES&H file, High-Pressure Test Facility Administrative Office, Room 1, Building 18.*

4. *"Control Data Checklists, Supervisor's ES&H file, High-Pressure Test Facility Administrative Office, Room 1, Building 18.*

5. *Guidelines for Line Organization ES&H Inspection and Monitoring Activities, ESH-12, issued by the ES&H Staff. Updated yearly.*

6. *"Institutional ES&H Program Plan," issued by the President's Office. Updated yearly.*

7. *Training Program for ES&H Committees, ESH-7, issued by the ES&H Staff.*

8. *Guidelines for Line Organization ES&H Review Activities, ESH-11, issued by the ES&H Staff. Updated yearly.*

9. *Quality Assurance Program, QA-2B, issued by the QA Section.*

10. *Pressure Safety Practices Manual, ESH-16, issued by the Safety Engineering Division of the ES&H Staff. Updated yearly.*

11. *Pressure Advisor Safety Manual ESH-17, issued by the Safety Engineering Division of the ES&H Staff. Updated yearly.*

12. *Pressure Technician Safety Manual, ESH-18, issued by the Safety Engineering Division of the ES&H Staff. Updated yearly.*

13. *Institutional Emergency Response Program, ESH-4, issued by the ES&H Staff. Updated yearly.*

14. *Files and training records in Division A ES&H supervisor's file, Administrative Office, Room 1, Building 18.*

APPENDIX C

Departmental Emergency Response Plan

The Institutional Emergency Response Program divides the Institution's property into five Sectors, each of which is required to have an Emergency Response Plan. Since this Department coincides with one of the five Sectors (Sector D), this appendix is both a Department Plan and a Sector Plan. Emergency planning for the Department's Remote Area operation is included in this plan.

Organization

The Institutional Emergency Response structure is shown in Figure C1. Control of response action is the responsibility of the Command Center, and all relevant communications are transmitted through the Command Center during an emergency.

The primary departmental locations are in Building 10, with Building 18 occupying the Remote Area. These areas are under the control of a Sector Chief during an emergency, as required by the Institutional Emergency Response Program. The Sector is divided into five zones, as shown in Figure C2, four in Building 10 and one in the Remote Area. Each of the four zones in Building 10 is directed by a Zone Lieutenant. The Remote Area (Division A operations) is under an Emergency Director (because of the need for independent action at this location). Three Emergency Squads (Extinguisher Squad, Evacuation Squad, and Equipment Squad) report to each Zone Lieutenant (or Emergency Director). The Zone 1 Lieutenant acts as alternate for the Sector Chief, and one member of each Evacuation Squad is assigned as alternate for his Zone Lieutenant. Current assignments will be found at the end of this appendix.

Figure C3 shows the floor plans for Building 10 in order to identify the areas included in each of the four zones in that building. Building 18 in the Remote Area (see Figure B1) constitutes the fifth zone.

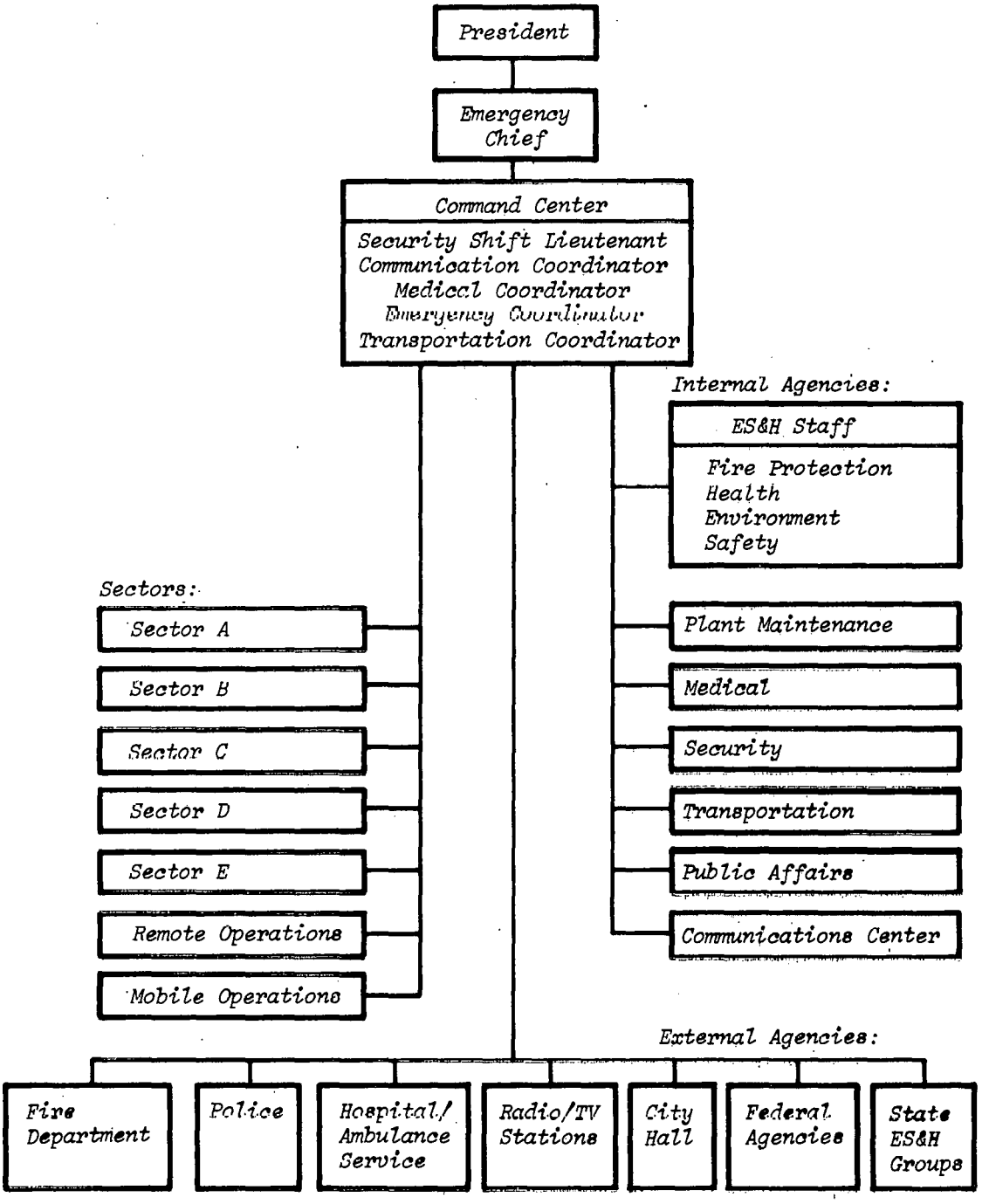


Figure C1. Institutional Emergency Response Structure

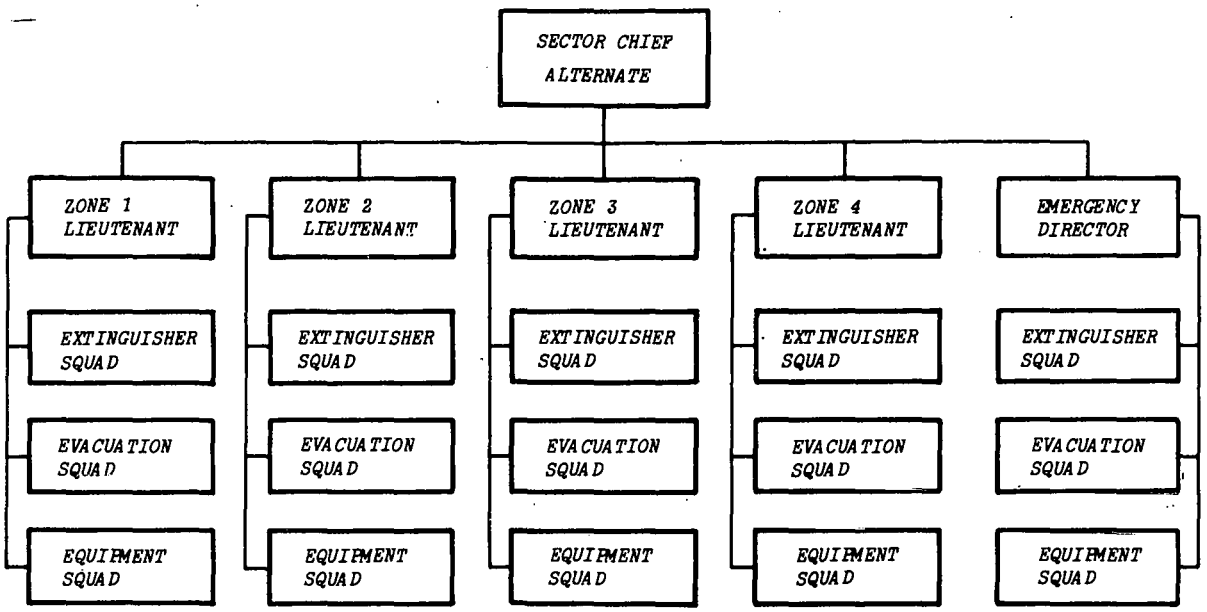


Figure C2. Sector Emergency Response Structure

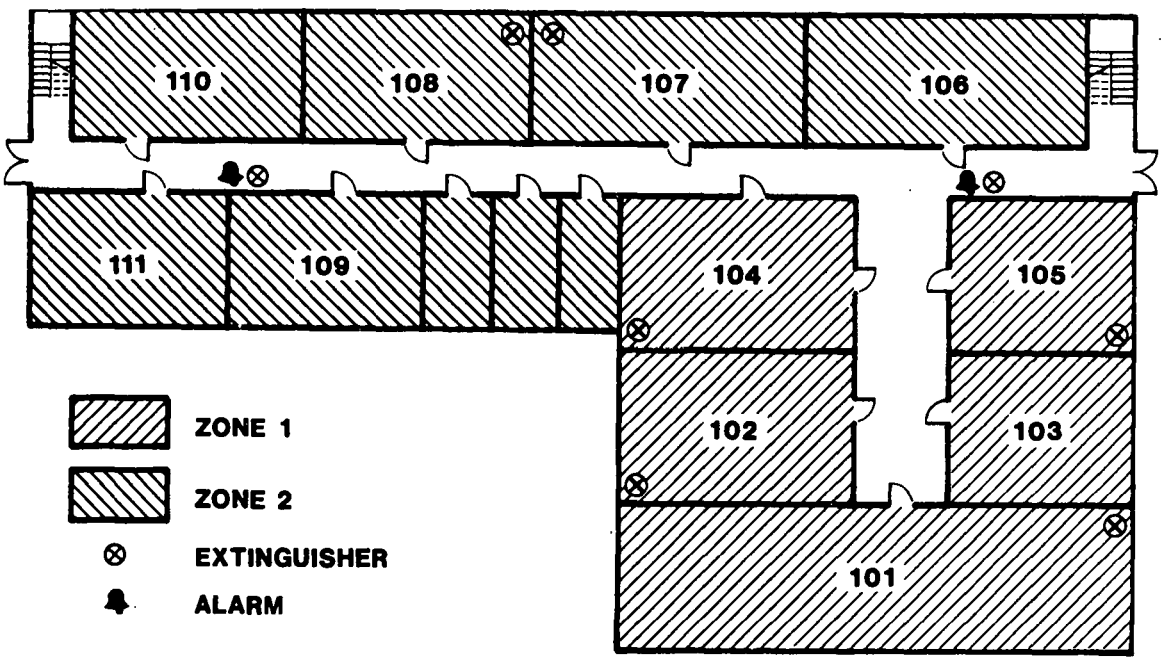


Figure C3a. Building 10, First Floor

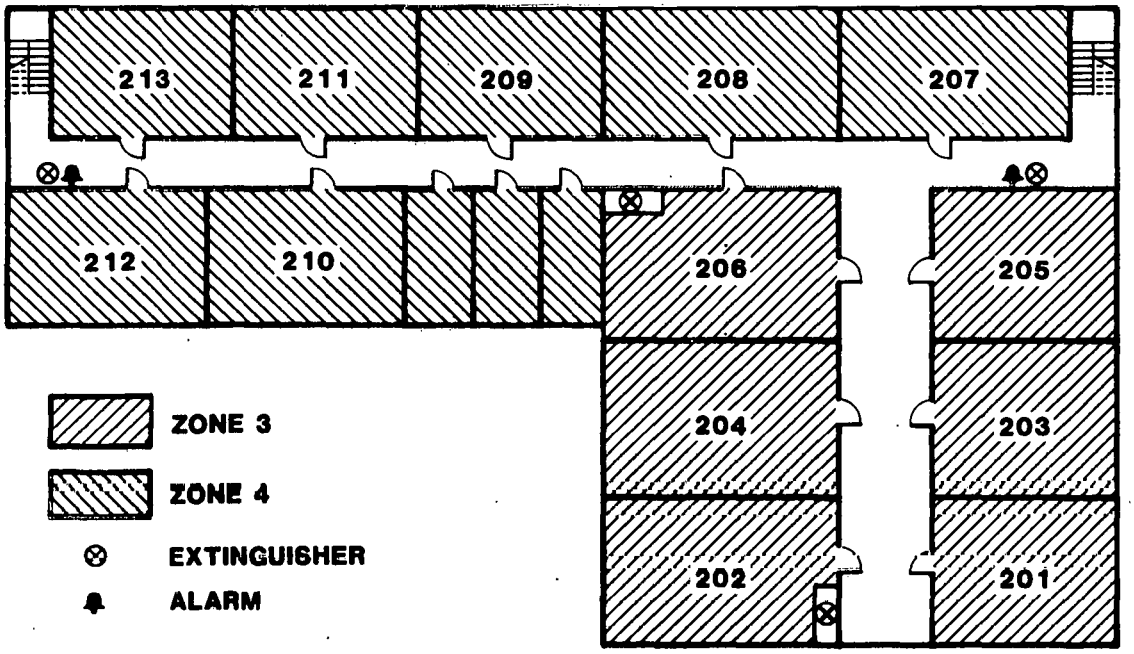


Figure C3b. Building 10, Second Floor

Responsibilities

1. *All Personnel*

   a. *All personnel should be alert to the occurrence of an emergency and should immediately initiate the appropriate alarm when one does occur. This includes sounding the fire alarm, calling for an ambulance, or informing the Sector Chief, as appropriate to the circumstances.*

   b. *When an alarm has sounded, personnel are to shut down all equipment being used and leave the building under the direction of the Sector Staff (Sector Chief, Zone Lieutenant or Emergency Director, and the Emergency Squads).*

   c. *Once outside the building, personnel are to stay clear of streets and, when the "all clear" signal is given, return to the work area.*

2. *Sector Chief*

   a. *The Sector Chief plans and organizes the emergency response for the Sector, prepares this Emergency Response Plan, arranges for assignment of responsibilities to individuals, arranges for training of Sector Staff members, maintains*

Sector Staff rosters and other records, and continuously updates all emergency response records.

b. *The Sector Chief directs all emergency response actions until professional units (Fire Department, etc.) arrive, receiving reports from and giving orders to the Sector Staff.*

c. *After the immediate emergency is over, the Sector Chief sounds the "all clear." However, when areas are contaminated or investigations will be required, the Sector Chief will arrange for securing the necessary areas.*

d. *After each emergency, the Sector Chief will arrange for a critique of the response (primarily using the Sector Staff) and report the critique results to Departmental management, the Institutional Emergency Chief, and the Emergency Coordinator of the ES&H Staff organization.*

3. *Zone Lieutenants and Emergency Director*

a. *The Zone Lieutenants and the Emergency Director assist the Sector Chief in preparation of the Emergency Plan, arranging for training and instruction of Sector Staff, and maintenance of records.*

b. *During an emergency, the Zone Lieutenants direct the activities of the Squads in their zones, report to the Sector Chief, and relay the Sector Chief's instructions to the Squads. The Emergency Director assumes the duties of Sector Chief for the duration of an emergency in the Remote Area.*

c. *After the emergency, the Zone Lieutenants and Emergency Director assist the Sector Chief, as necessary, in restoring normal operations and in critiquing the response.*

4. *Emergency Squads*

a. *Extinguisher Squad*

The Extinguisher Squad proceeds to the extinguisher locations when the alarm is sounded and either uses the extinguishers (if the emergency is a fire) or stands by for the possibility of a fire.

b. *Evacuation Squad*

The Evacuation Squad directs the evacuation of personnel from the building and is also trained to provide first aid

or to perform emergency rescue operations, as directed by the Sector Chief or Zone Lieutenants.

c. *Equipment Squad*

The Equipment Squad checks that all equipment has been deenergized and mans emergency equipment such as sprinkler valves. Depending on the type of emergency, the Equipment Squad is also responsible for cutting off utilities (gas, electricity, water) when required by the situation.

Sector Emergencies

When an emergency arises within the Sector, the Sector Chief immediately notifies the Command Center. Depending on the type of emergency, the Command Center may issue directives to the Sector, but the normal actions of the Command Center consist of calling on professional help and dispatching the specialist coordinators to the scene of the emergency, as appropriate.

Concurrently with the notification action, or as soon as possible, the Emergency Squads are put into action performing the functions listed above.

Emergencies arising in the Remote Area also entail notification and Emergency Squad operations. The Emergency Director and the Emergency Squads at the Remote Area must be prepared to cope with the emergency for a longer time interval (than is the case in Building 10) before professional help arrives.

Plant-Wide Emergencies

Response to plant-wide emergencies will rely primarily on use of shelters or an evacuation plan, as described in the Institutional Emergency Response Plan. Actions taken by Sector personnel will be as directed from the Command Center.

Communications

Both radio and telephone equipment is available for communication between the Command Center and the Sector Chief, between the Command Center and the Remote Area, and between the Sector Chief and the Remote Area. Instructions for initiating and receiving communications over these systems is included in the Institutional Emergency Response Plan. Periodic tests are conducted as a part of the Institutional program.

Within Building 10, communication between the Sector Chief and Sector personnel is by bullhorns available at the Sector Chief and Zone Lieutenant stations. The Remote Area is small enough that voice communication suffices for internal communication.

Training

The Sector Chief, the Zone Lieutenants, and the Emergency Director are trained in all aspects of the Emergency Response Program, particularly in communication techniques. Training is accomplished through a course provided by the ES&H Staff organization. Annual refresher courses are required.

Members of the Evacuation Squad receive training in first aid prior to their assignment and are required to take refresher courses annually. All Department personnel, including those at the Remote Area location, receive training through ES&H meetings, instruction displays, and periodic evacuation drills. All training records are maintained in the Department ES&H file, Department Office, Building 10.

Quality Control

All extinguishers are periodically, randomly, sampled for performance. No extinguisher is maintained in service beyond 3 years. Sprinkler systems, which are present in all rooms, are tested (dry) at least once each year. Bullhorns in Building 10 are tested weekly. Test results are recorded and filed in the Departmental ES&H Records, Department Office, Building 10.

Program Evaluations

In addition to the emergency response critiques arranged by the Sector Chief after each emergency, the total program is evaluated annually. The evaluations are conducted by a team composed of the Sector Chief, the Zone Lieutenants, and the Emergency Director, and reports on the evaluations are submitted to the Department Manager, the ES&H Staff organization, and the Institutional Emergency Chief. Results are on file as a part of Departmental ES&H Records, Department Office, Building 10.

Current Departmental Emergency Response Assignments

Sector Chief _____

Zone 1 Lieutenant _____

Zone 1 Extinguisher Squad _____

_____

_____

Zone 1 Evacuation Squad _____ *(Alternate Lt.)*

_____

_____

Zone 1 Equipment Squad _____

_____

_____

Zone 2 Lieutenant _____

Zone 2 Extinguisher Squad _____

_____

_____

Zone 2 Evacuation Squad _____ *(Alternate Lt.)*

_____

_____

Zone 2 Equipment Squad _____

_____

_____

Zone 3 Lieutenant _____

Zone 3 Extinguisher Squad _____

_____

_____

Zone 3 Evacuation Squad _____ *(Alternate Lt.)*

_____

_____

Zone 3 Equipment Squad _____

_____

_____

Zone 4 Lieutenant _____

Zone 4 Extinguisher Squad _____

_____

_____

Current Assignments (continued)

Zone 4 Evacuation Squad _____ *(Alternate Lt.)*

Zone 4 Equipment Squad _____

Emergency Director _____

Remote Area Extinguisher Squad _____

Remote Area Evacuation Squad _____ *(Alternate Em. Dir.)*

Remote Area Equipment Squad _____

Use of the Model Plan To Develop a Line Organization ES&H Assurance Plan

The Line organization program is, in many ways, the key part of the institutional ES&H Assurance Program. The assurance subprogram of the ES&H Staff organization cannot be effective unless there is a control subprogram operated by the Line organization to provide the evidence necessary for assurance.[17] The Line organization is the only place where this evidence can originate, so that *without* the Line ES&H program, there can be *no ES&H assurance*.

A Line organization plan must specify how each of the six basic generic criteria (given earlier) for success in ES&H programs are to be met. That is, it must specify how, by whom, and when

- Hazards are to be identified,
- Acceptable controls are to be defined,
- Consistent use of the controls is to be enforced,
- Changes are to be accommodated,
- Preparations are to be made for emergencies, and
- Evidence of the performance of the above is to be provided.

The model plan presented in this document is an example of the specification for a program that will meet these six criteria. The specifications are presented in the following format:

1. An administrative section, which specifies how, by whom, and when the functions necessary for meeting the criteria are performed,
2. *Appendix A*, which specifies the elements of the program about which evidence of performance is evaluated (see References 11, 12, and 13),
3. *Appendix B*, which describes the organizations' facilities and operations, lists the hazards identified, and defines the controls established, and
4. *Appendix C*, which describes a particular control system, the Emergency Response Program for the Line organization.

Such a model plan may be used as guidance in developing a specific Line organization ES&H Assurance Program Plan, but the format shown is by no means mandatory. The functions shown in the model are those that satisfy the Standard and the six criteria, but these functions may be implemented in different ways. As one example, the controls that are developed must be documented (to serve as evidence), but the documentation need not be in the form of an appendix to the plan, as it is here. Such documentation might only be referenced in the plan--the important point is that it must exist.[10]

To develop a Line organization ES&H Assurance Program Plan, it is recommended that a task force be appointed to carry out the development. The task force might be the forerunner of an ES&H Committee, such as that used in the model plan, or might be an *ad hoc* group consisting mostly of supervision. Whatever form the task force takes, it is strongly recommended that its members receive training from the ES&H Staff organization before beginning its task.

The following discussion of plan development will use the model plan as a framework under which the development steps may be considered. *Appendix B* will be discussed first. This appendix represents the "output" of that part of the ES&H program that deals with the analysis of hazards and the development of controls--the control subprogram. It is recommended that the task force address this part of the program first and leave the development of the administrative structure until later because the administrative format should be tailored to the hazards encountered in the organization and the needed types of controls.

After identifying hazards and developing controls (including the emergency response controls in *Appendix C*), the development of the administrative section of the plan would be the next step to be taken by the task force.

Appendices B and C

As the output of the activities undertaken to meet Criteria I and II, *Appendix B* begins with a listing of the facilities and projects under the control of the Line organization. The Standard requires maintenance of such a listing for all facilities, projects, and activities that present significant hazards, but a complete listing is an excellent starting point for the task force because it facilitates the identification of hazards. Such a listing (kept up-to-date, of course) will also be useful later in the program for such assurance activities as the planning of audits.[3,11]

The second part of *Appendix B* is the hazard listing, which is the documentation of the results of activities carried out in satisfying Criterion I. Some of the significant hazards encountered in a Line organization may be fairly routine in spite of having significant potential for injury or damage, and it is efficient to list these by classes rather than as individual hazards (e.g., all lathes in a machine shop might be included in the list as a single entry).[10] Those routine hazards that are not significant are usually addressed through institutional-type controls, such as "standard practices." The second step for the task force, then, is to study all facilities, projects, and activities in the organization and to identify the hazards involved.

The third part of *Appendix B* is entitled "Hazard Analysis, Mitigation Measures, and Controls" and is the documentation associated with Criterion II. This part describes each hazard, analyzes how the potential consequences might be realized, describes the design controls and operational controls developed for each hazard, and discusses the acceptability of the risk that exists when the controls have been instituted.

Detailed guidance for the hazard analysis and mitigation functions is contained in Reference 10. In brief, there must be an analysis activity to determine how (through what events) a hazard's potential for harm might be realized, a control identification activity, and a control

selection activity. The possible controls are of two types: the technical or design controls, which are physically implemented to mitigate or prevent hazard consequences, and the administrative or procedural controls, which mitigate either by controlling the implementation of the technical controls or by controlling the human part of the operation. Note that at least some of the controls applied to equipment or material may be assigned to the institutional QA Program. See Reference 15 for guidance in utilizing an existing QA Program. At this time, Emergency Response Controls (*Appendix C*) should be considered. *Appendix C* represents one form of hazard control in that it is aimed at mitigating the consequences of hazards when they are realized. It is the application of an institutional emergency response plan (see Reference 5) to the Line organization. Such application will normally consist of repeating the pertinent portions of the institutional plan and assigning the Line organization responsibilities required by the plan.

Emergency response actions that take place during the events that lead to hazard consequences (rather than after the events) are under the control of the Line organization through the controls developed to satisfy Criterion II (see *Appendix B*). For example, a procedure may specify that power must be turned off whenever certain event indications appear. Such response actions should always be considered for inclusion in operating procedures or *Appendix B*.

The next step to be taken by the task force should be to compile the existing documentation on hazard analysis and on the controls that are in effect. The documentation may be in a variety of formats, and important parts of it may be missing, but the task force should organize what does exist in order to obtain a picture of the existing control program. This background will provide a basis for developing the administrative portion of the plan, not only because it points to existing weaknesses that need to be corrected, but also because it is desirable to tailor the plan to fit existing operations to the greatest extent possible.

Administrative Section

In developing the administrative section of the plan, the task force must begin with the requirements imposed by the institution and expressed in the institutional ES&H Program Plan and ES&H Staff program and guidance documents (*Figure 2*, earlier). The model Line organization

plan presented in the previous section has, to the best of our ability, been so developed and thus illustrates how a Line organization plan may be derived from an institutional program. The ES&H Staff documentation in these models[2-15] is in some cases, perhaps, more specific about requirements on the Line organization than most, but even when such specificity exists, the task force should be encouraged to use creativity and ingenuity in devising a plan that meets the imposed requirements and yet satisfies the Line organization's needs in the most effective and efficient manner.

The first parts of the administrative section are a statement of scope and policy. The Line plan may be considered as a translation of the institutional plan for the use of Line personnel and thus should not omit the policy part of the institutional message. The active support of management is required by the Standard, and this support is very effectively expressed by a statement of Line policy.

The next part deals with the ES&H organizational structure in the Line organization. The institutional plan, in this model case, has specified a particular structure, using a Line ES&H Committee as the assurance arm of the organization (see References 2 and 9). When a structure is not specified, the task force will have more latitude in devising one, but there is one important concept that should be incorporated: the independence of the individual or group performing the assurance function. The ES&H Committee has a degree of independence because it reports to the Department Manager, in the model plan, and if any other structure is used, it should also provide as much independence as possible for the assurance function.

Following the organization section, the plan addresses "Assigned Responsibilities" and "Program Requirements." These two topics include the specification of the ES&H functions of the Line organization, why they are performed, who is to perform each function, and when. As noted, these functions may be grouped as control, assurance, and support functions.

The task force must make certain that the responsibility for, and nature of, control and assurance functions is clearly stated. Guidance will be found in References 2, 5, 7, 9, 10, 14, and 15 for control functions.

The assurance functions include performing selected reviews, monitoring and inspecting for change, and auditing the program to verify use of the plan and the controls. Guidance for these functions is provided in References 2, 7, 11, 12, and 13.

The support functions that may be included in an ES&H assurance program include a spectrum of activities. A primary support function is that of providing guidance. Guidance is provided by the institution's ES&H Staff organization, but the Line organization needs to bring such guidance to the point of operation. An ES&H committee or similar group can provide such onsite guidance either through training or consultation with the Staff.

Another important support function is that of overseeing personnel input to the program. Personnel participation is required by the Standard. One way to enhance personnel participation is to provide for effective ES&H meetings (see Reference 14) where personnel are encouraged to discuss and evaluate the ES&H program and make suggestions for its improvement. When an ES&H Committee is made part of the Line organization program, it is effective for this Committee to manage the ES&H meeting program.

Other essential support functions include the maintenance of records, the conduct of investigations, and the arrangement for training in ES&H matters when needed. Again, the ES&H Committee is an effective vehicle for performing these functions, but other methods may be used.

Completion of Plan Development

Although the Line organization's ES&H Assurance Program plan is never considered to be complete, in the sense of being fixed for all time, there will be a point at which the task force is ready to submit the plan for management approval. The institutional plan would normally require that the Line organization plan be submitted to the ES&H Staff organization for review before it is approved. The Staff does not approve the plan but certifies to management that it is adequate. Of course, when the Staff finds deficiencies in the plan, there will have to be revisions and resubmittals.

After the plan is approved by management, the next step is implementation of the plan, as specified in its administrative section. If

the task force is an *ad hoc* group, its task would then be considered complete.

This is the last in a series of 15 documents designed to illustrate in some detail how the administrative portions and some facets of the technical portions of an ES&H Assurance Program might be implemented. The authors have found this an arduous task and apologize for the occasional variation in the level of detail that has occurred among some of the documents. To the best of our knowledge and ability, however, the model program presented throughout the 15 documents is both self-consistent and consistent with the requirements of the ES&H Assurance Program Standard. We genuinely hope that our efforts will encourage and assist individuals interested in implementing an ES&H Assurance Program.

Notes and References

1. This Standard occurs in several references. The first version was preliminary and was altered as a result of a broad review process. It is found in A. C. Ellingson, C. A. Trauth, Jr., and M. S. Tierney, A Proposed Standard for ES&H Assurance Programs, SAND79-0240 (Albuquerque: Sandia Laboratories, March 1979).

   A version, revised as a result of this review, is given in

   A. C. Ellingson and C. A. Trauth, Jr., An Environment, Safety and Health Assurance Program Standard, SAND79-1536C (Albuquerque: Sandia Laboratories, October 1979).

   and in

   A. C. Ellingson and C. A. Trauth, Jr., An Environment, Safety and Health Assurance Program Standard: An Analysis in the Context of DOE ES&H Requirements, SAND79-1536 (Albuquerque: Sandia Laboratories, September 1979).

   See also Reference 17, below.

References 2 through 16 are a part of a series generically entitled "Guidance for Implementing an Environmental, Safety and Health Assurance Program." Separate volume titles are as follows.

2. C. A. Trauth, Jr., A. C. Ellingson, and K. Marston, Volume 1. A Model Plan for Institutional Environmental, Safety and Health Assurance Programs, SAND81-0632 (Albuquerque: Sandia National Laboratories, June 1981).

3. A. C. Ellingson, Volume 2. A Model Plan for Environmental, Safety and Health Staff Audits and Appraisals, SAND81-0633 (Albuquerque: Sandia National Laboratories, September 1981).

4. A. C. Ellingson and C. A. Trauth, Jr., Volume 3. A Model Plan for Environmental, Safety and Health Staff Review Activities, SAND81-0634 (Albuquerque: Sandia National Laboratories, January 1982).

5. A. C. Ellingson and E. L. Gunderson, Volume 4. A Model Plan for Institutional Emergency Response Programs, SAND81-0635 (Albuquerque: Sandia National Laboratories, June 1981).

6. C. A. Trauth, Jr. and A. C. Ellingson, Volume 5. A Model Plan for Institutional Accident Investigations, SAND81-0636 (Albuquerque: Sandia National Laboratories, January 1982).

7. "Volume 6. Model Documentation for an Environmental, Safety and Health Assurance Information System," SAND81-0637 (Albuquerque: Sandia National Laboratories, to be published).

8. A. C. Ellingson, C. A. Trauth, Jr., and K. Marston, Volume 7. A Model Plan for Institutional Environmental, Safety and Health Assurance Training Programs, SAND81-0638 (Albuquerque: Sandia National Laboratories, January 1982).

9. A. C. Ellingson, C. A. Trauth, Jr., and L. M. Jercinovic, Volume 8. Model Guidelines for Line Organization Environmental, Safety and Health Committee Operations, SAND81-0639 (Albuquerque: Sandia National Laboratories, June 1981).

10. C. A. Trauth, Jr. and K. Marston, Volume 9. Model Guidelines for Environmental, Safety and Health Analysis Activities, SAND81-0640 (Albuquerque: Sandia National Laboratories, June 1981).

11. A. C. Ellingson, Volume 10. Model Guidelines for Line Organization Environmental, Safety and Health Audits and Appraisals, SAND81-0641 (Albuquerque: Sandia National Laboratories, October 1981).

12. A. C. Ellingson and C. A. Trauth, Jr., Volume 11. Model Guidelines for Line Organization Environmental, Safety and Health Review Activities, SAND81-0642 (Albuquerque: Sandia National Laboratories, January 1982).

13. A. C. Ellingson, Volume 12. Model Guidelines for Line Organization Environmental, Safety and Health Inspection and Monitoring Activities, SAND81-0643 (Albuquerque: Sandia National Laboratories, August 1981).

14. A. C. Ellingson, C. A. Trauth, Jr., and L. M. Jercinovic, Volume 13. Model Guidelines for Line Organization Environmental, Safety and Health Meetings, SAND81-0644 (Albuquerque: Sandia National Laboratories, June 1981).

15. A. C. Ellingson, Volume 14. Model Guidelines for Utilizing Quality Assurance Support in ES&H Assurance Programs, SAND81-0645 (Albuquerque: Sandia National Laboratories, August 1981).

16. A. C. Ellingson and C. A. Trauth, Jr., Volume 15. A Model Plan for Line Organization Environmental, Safety and Health Assurance Programs, SAND81-0646 (Albuquerque: Sandia National Laboratories, January 1982).

17. C. A. Trauth, Jr., A. C. Ellingson, H. Hollister, and L. M. Jercinovic, A Program Standard for Assuring That Today's Management Obligations in Environmental, Safety and Health Areas Are Met, SAND 1359C (Albuquerque: Sandia National Laboratories, June 1981).

18. Two papers are of relevance here. First, C. A. Trauth, Jr. and Jay B. Sorenson, "A New Approach for Assuring Acceptable Levels of Protection from Occupational Safety and Health Hazards," an invited presentation to the Southwest Labor Studies Conference held at the University of New Mexico, 1 May 1981.

The second paper is

Jay B. Sorenson and C. A. Trauth, Jr., "The Political Side of Risk: A New Approach," in the Proceedings of the 1980 Annual Meeting of the American Political Science Association, August 1980, Washington, D.C.

19. The National Environmental Policy Act (42 U.S.C. 4321 et seq.), as amended, and regulations issued by the Council on Environmental Quality (40CFR Part 1500, 36FC 20550).

20. The Occupational Safety and Health Act of 1970 (84 Stat. 1593, 1600; U.S.C. 655, 657), as amended.

21. C. A. Trauth, Jr., A. C. Ellingson, D. E. Farr, and L. M. Jercinovic, A Study of the Application of Quality Assurance, Human Factors and Reliability Principles to the Prevention of Major Environmental, Safety and Health Incidents, SAND78-2176 (Albuquerque: Sandia Laboratories, December 1978).

22. A. C. Ellingson, Audit/Appraisal Guidelines for Organizational ES&H Assurance Programs, SAND79-1812 (Albuquerque: Sandia Laboratories, November 1979).

23. Anon., "Working Guidelines for Performing Safety Analysis Activities and for Reviewing Safety Analyses," U.S. Department of Energy, to be published.

DISTRIBUTION:

U.S. Department of Energy (2)
Office of Environmental Protection, Safety
and Emergency Preparedness
Washington, DC 20585
Attn: Mr. Hal Hollister

U.S. Department of Energy (10)
OOS
Washington, DC 20545
Attn: Mr. Henry Rosenthal

U.S. Department of Energy
OQA
Washington, DC 20545
Attn: J. T. O'Connor

DOE -- Albuquerque Operations Office (6)
P.O. Box 5400
Albuquerque, NM 87115
Attn: J. R. Roeder, Director, OSD

Ms. Karen Marston-Fox (5)
Tech. Reps., Inc.
5000 Marble NE
Albuquerque, NM 87110

Ms. Kelly King (2)
Safety Sciences, Inc.
7586 Trade St.
San Diego, CA 92121

Mr. Leslie M. White
Safety Sciences, Inc.
291 G Street, SW
Washington, DC 20024

400 C. Winter
1220 J. M. Wiesen
1400 L. J. Heilman
1410 W. C. Kraft
1417 F. W. Muller
1418 A. C. Ellingson
1418 C. A. Trauth, Jr. (50)
3300 P. B. Mossman
3310 W. D. Burnett
3400 D. S. Tarbox
3440 L. M. Jercinovic
3442 D. L. Rost
3442 M. M. Carroll
3662 V. L. Duke
8275 P. K. Lovell
8214 M. A. Pound
3141 L. J. Erickson (5)
3151 W. L. Garner (3)
3154-3 C. Dalin (25)
For DOE/TIC (unlimited release)