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ENVIRONMENTAL PROJECTS GROUP ENGINEERING OPERATIONS QUALITY ASSURANCE MANUAL

07/01/87

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MANUAL

This Manual is a statement of the quality assurance program (IT Corporation Environmental Projects Group Policies and Procedures Manual, Quality Assurance Policy Draft, January 31, 1987) adopted by IT Corporation (IT) Environmental Projects Group Engineering Operations so that quality is "built in" as part of the normal course of work rather than "after the fact." Specific actions to be taken during the course of work are included, as well as the overall system of "checks and balances" so that work quality can be verified and demonstrated. Engineering Operations includes activities related to:

- The determination of the substances present at a site
- The assessment of their effect upon the environment
- The evaluation and design of remedial measures
- The monitoring of remedial measures to demonstrate their success

Everyone involved in Engineering Operations affects resulting quality; therefore, everyone is involved in quality assurance. Within this Manual, "quality assurance" is defined as the overall system of controls applied to Engineering Operations and quality control is the individual actions taken within the system on a daily basis. For this Manual and the quality assurance program, quality control and quality assurance are:

- Quality Control - the daily, specific actions taken by engineering personnel to record information, perform and verify calculations and drawings, and prepare and maintain records. Basically, quality control is the part of the quality assurance program that builds quality into the work as work is performed, and which has the greatest impact upon the successful completion of the work. Quality control is conventionally considered standard professional practice.

- Quality Assurance - the total system of planned and systematic actions taken during the course of work so that adequate confidence in the end product exists. Included are actions taken by personnel and the documentation of their activities so that performance of work in accordance with the quality assurance program can be demonstrated. Reviews, such as checking and audits, are performed to provide verification. The quality assurance system provides additional activities beyond conventional quality control for verification, planning and demonstration.

OBJECTIVES OF THE QUALITY ASSURANCE PROGRAM

This Manual has been prepared to:

- Provide uniformity of engineering services within IT for frequently performed tasks applicable to most projects, regardless of the specific aim of the project. This includes defined policies for:

  - Field sampling and sample control
  - Preparation and review of calculations, drawings, and reports

- Control of computer software including verification and data management
- Peer review
- Procurement of outside services
- Personnel quality assurance/quality control responsibilities
- Preparation and control of quality assurance documents
- Personnel training
- Records preparation, collection, and maintenance

- Provision of continuity throughout a project so that the work progresses as an organized, planned sequence of events which allows revision and feedback during the course of work

- Provision of controls within a project by adopting the uniform practices cited in this Manual (such as noted above), or by developing specific controls because of the requirements for a project, so that the work is performed as directed and adequate "checks and balances" are included to verify the work

- Fulfillment of regulatory requirements pertinent to a specific project. This Manual has been prepared to satisfy the requirements of the U.S. Nuclear Regulatory Commission (NRC) and the U.S. Environmental Protection Agency (EPA) as stated in the following documents:

  - Title 10, Part 50, Appendix B of the Code of Federal Regulation, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants"

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As necessary, this Manual will be supplemented on a case-by-case basis to provide client project-specific requirements.

The objectives of the IT quality assurance program for engineering are met by the implementation of this Manual as discussed in the following sections.

SCOPE OF THE QUALITY ASSURANCE PROGRAM

The Engineering Operations quality assurance program includes aspects of a project which affect the quality of the end product. Figure 1 presents the sequence of stages which could be included in a typical engineering project. With each stage are shown typical activities. The sequence shown is the normal progression of a project, and in general before a specific stage can be completed, previous stages must be completed. Each stage affects resulting quality. If, for example, planning is not properly performed or adequate data acquired, subsequent stages are subject to uncertainty so that the goals of the project may

not be met. Also, with each stage, records must be prepared and maintained so that subsequent stages are provided the information required, and the adequacy of the work can be demonstrated at the conclusion of the project.

This Manual defines two levels of application of the quality assurance program to a project. The selected quality level can affect all stages of a project. The levels are defined below:

- Level I - The "standard" IT quality requirements are applied. There is minimal involvement of quality assurance personnel during the course of work and auditing is not generally performed.

- Level II - The maximum application of quality assurance practices and substantial participation of quality assurance personnel.

It is imperative that the level selected fulfills the necessary regulatory, client, and IT requirements.

Finally, it must be recognized that each stage can affect those that precede it. It is not unusual during the course of work for developments to occur which require previous work to be supplemented and/or changed. An example could be that during data acquisition, sampling must be done in the field using equipment which is different than specified. This results in a change of the initial planning so that sampling techniques are altered. During analysis, it may be determined that sufficient data are not available and the sampling plan must be changed to acquire more, or different data. Design may require changes and the changes must be reviewed and controlled in the same manner as the original work.

The quality assurance program presented in this Manual provides the continuity and controls necessary to perform an engineering project in a defined, systematic manner, including adequate provisions for changes. Specifically, subsequent sections discuss the following:

- Organization. Quality assurance responsibilities of the various members of the project and laboratory staffs are presented. In addition, responsibilities of quality assurance personnel are discussed.

- Quality Assurance Documents. The documents are available to provide control and direction, and the hierarchy of the documents are discussed. How documents are to be prepared, reviewed, approved, distributed, and revised are presented.

- Project Planning. The activities which must be considered, and as necessary completed, during the planning stage of a project prior to initiation of technical activities. This section deals with the planning stage of a project and includes:

  - Review of the quality assurance/quality control activities required by the project
  - Selection of quality level
  - Personnel qualification and training
  - Procurement of items and services
  - Proposal preparation

- Data Acquisition. The conclusions reached in most projects are founded upon the data obtained. This section discusses the control applied during literature surveys, field investigation and sampling, and laboratory analyses. The interaction of field personnel with the IT laboratories is stressed, particularly with regards to sample integrity.

- Modeling and Design. Computational activities and verification require specific controls so that thought processes, calculations, presentations, and reviews can be demonstrated. The controls used within IT are presented.

- Controlling Project Changes. The need for documenting, evaluating, and reporting project changes is discussed. The necessity of maintaining a current scope of work is emphasized.

- Nonconformance/Corrective Action. The means for identifying and reviewing nonconformances, notifying personnel, and the necessary follow-up are discussed. Nonconformance results from error, in which case corrective action is required.

- Report Preparation. Generally, the results of an engineering project are presented in a report, or by drawings and specifications. Guidelines are provided for the preparation and submittal of reports and the controls to verify that the report adequately presents the work performed.

- Records Management. All engineering projects must be adequately documented so that the work can progress and the results can be demonstrated. The records required for specific project activities are discussed in the sections preceding Section 10.0. The methods for collecting and maintaining these records are presented.

- Quality Assurance Audits. Certain engineering projects will be formally audited. The selection of projects for audit is based on regulatory requirements and/or the decision of IT management. In addition, generic audits of engineering operations and laboratories will be performed. The types of audits which can be performed and the procedures for performing and reporting an audit are discussed.

- Management Participation. To keep IT management informed of the application of the quality assurance program, audit results, nonconformances, and corrective action are reported to various management levels. The reporting requirements and management's responsibilities are presented. The direct responsibilities of management in the quality assurance program, and the management of IT are also discussed.

Certain sections in this Manual are directly applicable to specific stages of a project. Also, certain sections have applicability for all project stages.

APPLICABILITY OF QUALITY ASSURANCE MANUAL

QUALITY ASSURANCE MANUAL SECTIONS APPLICABLE TO SPECIFIC PROJECT STAGES

PROJECT STAGE	MANUAL SECTION
Proposal Preparation	Project Planning
Planning	Project Planning
Data Acquisition	Data Acquisition
Modeling and Design	Modeling and Design
Experimentation	Data Acquisition
Reporting	Report Preparation
Ongoing Monitoring	Data Acquisition

QUALITY ASSURANCE MANUAL SECTIONS APPLICABLE THROUGHOUT A PROJECT

Organization and Responsibility

Quality Assurance Documents

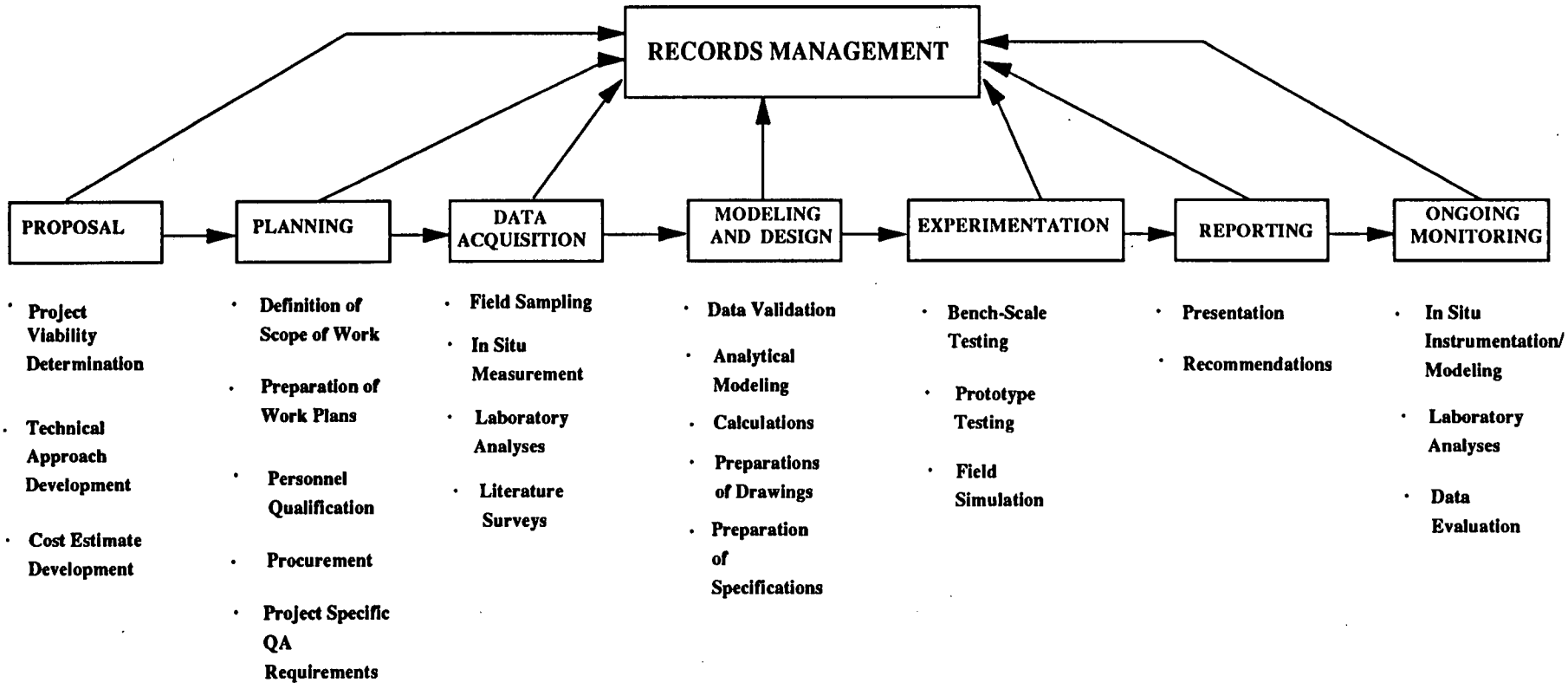
Controlling Project Changes

Nonconformance/Corrective Action

Records Management

Quality Assurance Audits

Management Participation



LEGEND:

——► Progress of Project

- - - - - - ► Flow of Documents

NOTE: The proposal and planning stages should be interrelated

FIGURE 1. STAGES OF A TYPICAL PROJECT

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INTERNATIONAL TECHNOLOGY CORPORATION

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Environmental Projects Group
Engineering Operations

July 1987

Quality Assurance Manual

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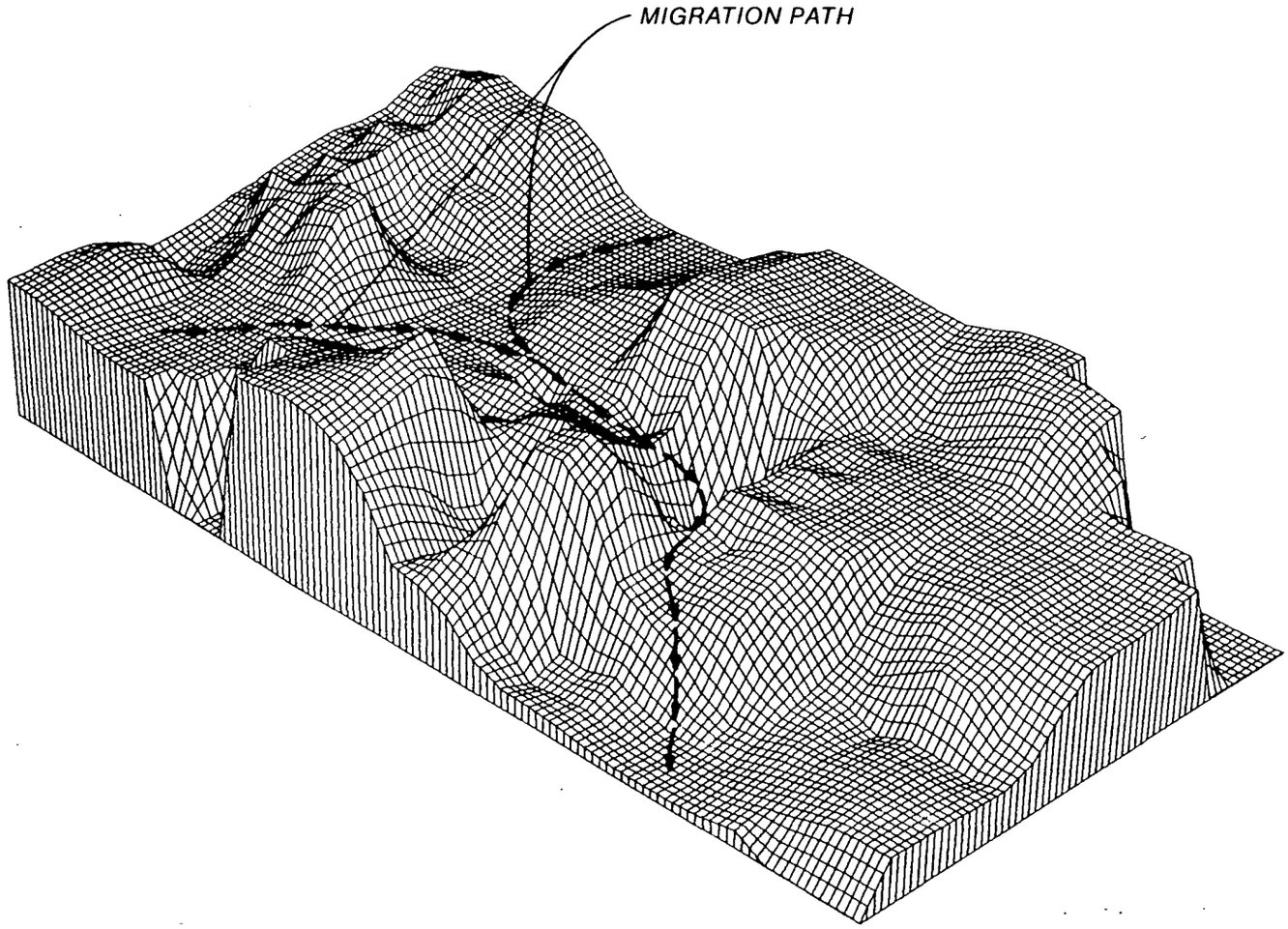

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RESPONSIVE TO THE NEEDS OF ENVIRONMENTAL MANAGEMENT

QUALITY ASSURANCE MANUAL
ENGINEERING OPERATIONS
IT CORPORATION
ENVIRONMENTAL PROJECTS GROUP

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STATEMENT OF MANAGEMENT POSITION

IT Corporation (IT) is committed to providing services for hazardous materials management which meet the technical and economic needs of our clients, satisfy regulatory requirements, and are commensurate with the current state of the art.

Part of the overall service provided by IT is engineering which can be applied to site investigation and assessment for the determination of in situ conditions, the design of process and facilities for the remediation of hazardous materials, and the design of new facilities for the treatment or containment of hazardous materials.

To provide direction for Engineering Operations so that it is performed in a controlled manner which can be demonstrated, IT has adopted an Engineering Operations Quality Assurance Program. This Manual is the statement of that Program. The Manual has been prepared considering the breadth of engineering performed by IT and is based upon generally accepted professional practice and current regulatory requirements. The Manual has been written so that it can be used by IT personnel to determine their responsibilities and the adopted means for fulfilling them. The Manual also serves as a statement to external parties of the IT Quality Assurance Program for Engineering Operations.

The Quality Assurance organization for implementing the Quality Assurance Program is described in this Manual. Day-to-day implementation of the Quality Assurance Program is the responsibility of all personnel in Engineering Operations. To assist them, a Quality Assurance Officer is assigned to each engineering office. The Quality Assurance Officer is responsible to the office Operations Manager. Overall responsibility for the direction and maintenance of the Quality Assurance Program rests with the Director, Quality Assurance and Discipline Management. To verify that the Quality Assurance Program is successfully implemented, engineering offices will be independently audited by the Director, Quality Assurance and Discipline Management, and staff.

All personnel must recognize their individual and collective responsibilities as defined herein and meet these responsibilities as part of their daily activities.

Raul A. Deju
Senior Vice President,
Environmental Projects Group

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1.0 INTRODUCTION

This Manual is a statement of the Quality Assurance Program(1) adopted by IT Corporation (IT) Environmental Projects Group Engineering Operations so that quality is "built in" as part of the normal course of work rather than "after the fact." Specific actions to be taken during the course of work are included, as well as the overall system of "checks and balances" so that work quality can be verified and demonstrated. Engineering Operations include activities in IT related to:

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This Manual defines two levels of application of the Quality Assurance Program for a project. The selected quality level can affect all stages of a project. The levels are defined below and the means for selection are presented in Section 4.2.

- Level I - The "standard" IT quality requirements are applied. There is minimal involvement of Quality Assurance personnel during the course of work, generally auditing is not performed.

- Level II - The maximum application of Quality Assurance practices and substantial participation of Quality Assurance personnel.

It is imperative that the level selected fulfills the necessary regulatory, client, and IT requirements.

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The Quality Assurance Program presented in this Manual provides the continuity and controls necessary to perform an engineering project in a defined, systematic manner, including adequate provisions for changes. Sections 2.0 through 12.0 provide the direction for the stages shown in Figure 1-1. Specifically, subsequent sections discuss the following:

- Section 2.0 - Organization. Quality Assurance responsibilities of the various members of the Projects and Laboratory Staffs are presented. In addition, responsibilities of Quality Assurance personnel are discussed.

- Section 3.0 - Quality Assurance Documents. The documents are available to provide control and direction, and the hierarchy of the documents are discussed. How documents are to be prepared, reviewed, and approved, distributed, and revised are presented.

- Section 4.0 - Project Planning. The activities which must be considered, and as necessary completed, during the planning stage of a project prior to initiation of technical activities. This section deals with the planning stage of a project and includes:

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  - Selection of quality level

  - Personnel qualification and training

  - Procurement of items and services

  - Proposal preparation.

- Section 5.0 - Data Acquisition. The conclusions reached in most projects are founded upon the data obtained. This section discusses the control applied during literature surveys, field investigation and sampling, and laboratory analyses. The interaction of field personnel with the IT laboratories is stressed, particularly with regards to sample integrity.

- Section 6.0 - Modeling and Design. Computational activities and verification require specific controls so that thought processes, calculations, presentations, and reviews can be demonstrated. The controls used within IT are presented.

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- Section 9.0 - Report Preparation. Generally, the results of an engineering project are presented in a

report, or by drawings and specifications. Guidelines are provided for the preparation and submittal of reports and the controls to verify that the report adequately presents the work performed.

- Section 10.0 - Records Management. All engineering projects must be adequately documented so that the work can progress and the results can be demonstrated. The records required for specific project activities are discussed in the sections preceding Section 10.0. The methods for collecting and maintaining these records are presented.

- Section 11.0 - Quality Assurance Audits. Certain engineering projects will be formally audited. The selection of projects for audit is based on regulatory requirements and/or the decision of IT management. In addition, generic audits of engineering operations and laboratories will be performed. The types of audits which can be performed and the procedures for performing and reporting an audit are discussed.

- Section 12.0 - Management Participation. To keep IT management informed of the application of the Quality Assurance Program, audit results, nonconformances, and corrective action are reported to various management levels. The reporting requirements and management's responsibilities are presented. The direct responsibilities of management in the Quality Assurance Program, and the management of IT, are also discussed.

Certain sections in this Manual are directly applicable to specific stages of a project. Table 1-1 correlates these sections and stages. Also, certain sections have applicability for all project stages; these are also listed in Table 1-1.

TABLE 1-1

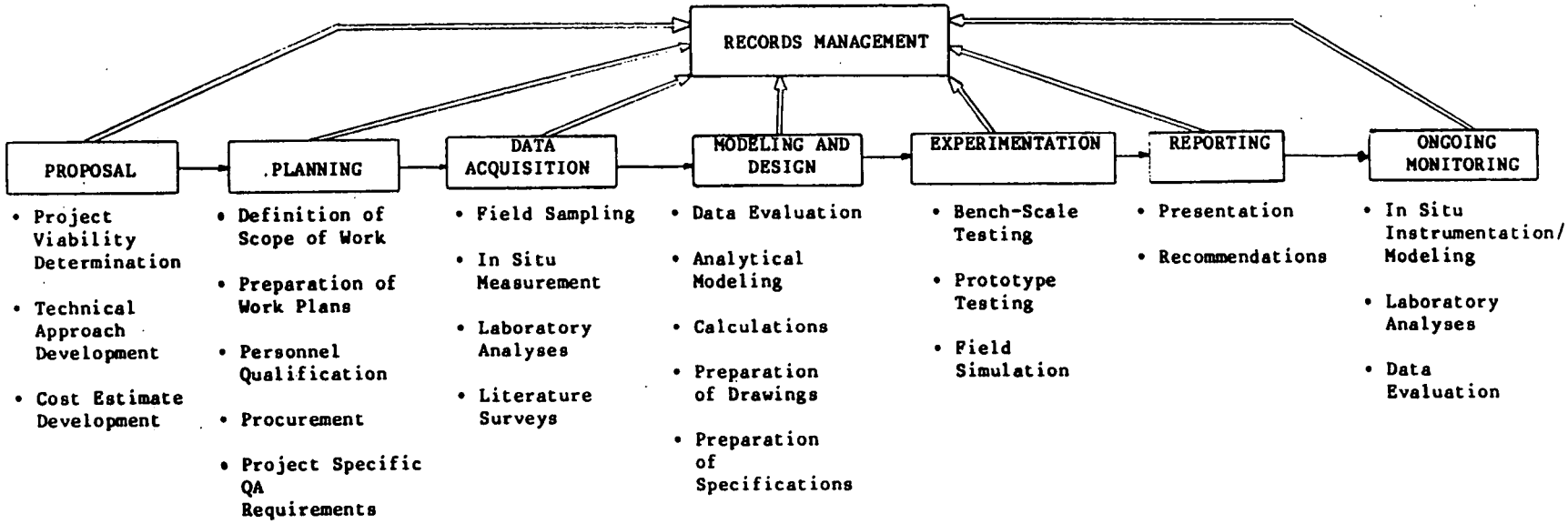
APPLICABILITY OF QUALITY ASSURANCE MANUAL

QUALITY ASSURANCE MANUAL SECTIONS
APPLICABLE TO SPECIFIC PROJECT STAGES

PROJECT STAGE	MANUAL SECTION
Proposal Preparation	4.0 - Project Planning
Planning	4.0 - Project Planning
Data Acquisition	5.0 - Data Acquisition
Modeling and Design	6.0 - Modeling and Design
Experimentation	5.0 - Data Acquisition
Reporting	9.0 - Report Preparation
Ongoing Monitoring	5.0 - Data Acquisition

QUALITY ASSURANCE MANUAL SECTIONS
APPLICABLE THROUGHOUT A PROJECT

2.0 - Organization and Responsibility
3.0 - Quality Assurance Documents
7.0 - Controlling Project Changes
8.0 - Nonconformance/Corrective Action
10.0 - Records Management
11.0 - Quality Assurance Audits
12.0 - Management Participation



LEGEND:

——————> Progress of Project
=========> Flow of Documents

NOTE: The proposal and planning stages should be interrelated.

FIGURE 1-1

STAGES OF A TYPICAL PROJECT

2.0 ORGANIZATION AND RESPONSIBILITY

Engineering services are provided by IT through the Environmental Projects Group Engineering Operations offices which serve geographical regions or provide specific areas of technical expertise on a national basis. As described in the Environmental Projects Group Policies and Procedures Manual Section 2.0 - Organization/Position Descriptions, each office, or engineering group within an office, is directed by a General Manager or Manager (generally referred to in this Manual as the Operations Manager). These individuals are responsible for the overall direction (technical, administrative, financial) of each project under their supervision including application of the Quality Assurance Program. Groups of Engineer Operations offices or groups within an office report to a Regional Operations Director or a Regional Vice President. These individuals are responsible for the overall direction and operation of the offices under their supervision, including application of the Quality Assurance Program. The Regional Operations are responsible to the Senior Vice President, Environmental Projects Group, who is responsible for all Environmental Projects Group operations. Project Managers and Project Directors selected to direct individual projects, are responsible for the day-to-day supervision of each project, including fulfillment of their Quality Assurance responsibilities. For large projects, several Project Managers, each directing a specific area, may report to a Project Director, who has overall responsibility for the project.

Considering the definitions in Section 1.0 for Quality Assurance and Quality Control, the responsibilities of the Operations Managers, Project Managers, and Project Directors are primarily related to Quality Control. The Quality Assurance system is the responsibility of personnel whose primary function is the application of the Quality Assurance Program. These Quality Assurance personnel include the Quality Assurance Officers located in the engineering offices and the Environmental Projects Quality Assurance Group.

Quality Assurance Officers are administratively and technically part of the staff of their respective offices. However, it is their responsibility to implement the overall Quality Assurance Program as presented in this Manual.

The Environmental Projects Quality Assurance Group is independent of all groups within the Environmental Projects Group. This provides the Quality Assurance Group with the independence necessary to develop, approve, and audit the Quality Assurance Program discussed herein and provide an overview of its implementation. The Environmental Projects Quality Assurance Group is responsible to the Senior Vice President, Environmental Projects Group. The Senior Vice President reports to the Chief Executive Officer of IT.

Figure 2-1 shows the basic organizational structure for a typical project. The manufacturing, laboratories, and project management groups within IT have been included, although they generally are not part of Engineering Operations, because of their role in most projects. Following are discussions of the roles and quality-related responsibilities of the individual groups shown in Figure 2-1.

2.1 PROJECT QUALITY ASSURANCE REVIEW COMMITTEE

To serve as a forum for the implementation and communication of the Quality Assurance Program to a specific project, a Project Quality Assurance Review Committee is established for each project. The members, as indicated in Figure 2-1, are: the Operations Manager; the Project Director and/or the Project Manager, as appropriate; and the Director, Quality Assurance and Discipline Management. (At the discretion of the Director, Quality Assurance and Discipline Management, the Quality Assurance Officer will fill the Director's position.) All members have equal status on the committee, with the Operations Manager serving as the Chairperson. The committee is the policy-making body for all quality-related items concerning the project including: determination and documentation of project quality level selection as presented in Section 1.2 and discussed in Section 4.2), review of revisions

or additions to existing procedures and/or Quality Assurance documents needed for the project, review of regulatory and client Quality Assurance requirements, and resolution of nonconformances and requests for corrective action.

If a project is planned and executed solely within the provisions of this Manual for "established quality practices," the committee is only required to select the project quality level. Quality Level I shall apply to projects unless specific action is taken to implement Level II. Established practice is defined as the following:

- The project is performed at Quality Level I (as defined in Section 4.2)
- Technical procedures exist for the performance of all field sampling, testing, and analyses
- Provisions contained in this Manual for quality practices, such as the reviewing of calculations, are adequate
- Adequate provisions are included in this Manual to satisfy client and regulatory requirements
- Nonconformances occurring during the course of work are resolved as discussed in this Manual
- Requests for corrective action resulting from audits are resolved as recommended in the audit report.

If any of these conditions are not met, the Project Quality Assurance Review Committee shall resolve the issue.

2.2 PROJECT PERSONNEL

It is the responsibility of project personnel to implement the quality practices established for the project. Usually, these requirements will be the Quality Control activities required of Level I projects (as defined in Section 4.2). However, project-specific activities may also be included.

The Senior Vice President, Environmental Project Group, is ultimately responsible for all IT engineering projects. For the conduct of projects, the responsibilities of the Senior Vice President are delegated to the appropriate Operations Managers via the Regional Directors. These individuals' quality-related responsibilities include, as appropriate:

- Selection of the Project Manager and Project Director
- Participation in the Project Quality Assurance Review Committee
- General supervision of the project
- Approval, as required, of project-specific Quality Assurance documents. This duty may be delegated to the Project Director assigned to the specific project
- Approval of procurement documents
- Stop work on a project if necessary because the project cannot be completed to the quality level required, or the schedule or budget do not permit successful completion.

Each specific project will be directed by a Project Manager or Project Director. Reporting to the Project Manager may be several individuals fulfilling as required the roles of Field Supervisor, Principal Investigator, Technical Advisor, and Project Engineer/ Scientist. Individuals, and positions filled, will be dependent upon project needs. All are responsible for fulfilling appropriate portions of the Quality Assurance Program, in accordance with assignments made by the Project Manager. However, for all projects, the Project Manager or Project Director is responsible for satisfactory completion of the Quality Assurance Program.

General responsibilities of the Project Manager and Project Director are:

- Participation in the Project Quality Assurance Review Committee

- Organization of the Project Staff and assignment of responsibilities
- Understanding of contract and scope of work for a specific project
- Communication to the Project Staff of project-specific client and regulatory requirements and Quality Assurance practices
- Day-to-day execution of the project
- Identify, document, and notify the client and Project Staff of changes in the scope of work
- Notify the Operations Manager if the project cannot be completed as completed with regards to quality, schedule, or cost
- Procurement of subcontractor services
- Supervision of preparation and approval of project-specific procedures, work plans, and Quality Assurance Plans
- Approval of project design bases, design parameters, drawings, and reports
- Dissemination of project-related information from the client such as design bases, input parameters, and drawings
- Liaison for communications with the client and subcontractors
- Liaison between the Project Staff and other internal groups, such as the laboratories
- Decision of whether or not drawings require independent checking
- Serving as the "collection point" for Project Staff reporting of nonconformances and changes in project documents and activities
- Determination of the effect of nonconformances on the project and the appropriateness for reporting such items to the client, and providing appropriate documentation for any reporting

- Notification of Project and Quality Assurance personnel of nonconformances and changes
- Notification of the Project Staff and, as appropriate, Quality Assurance personnel of void project-related documents and information
- Determination that changes, revisions, and rework are subject to the same Quality Control requirements as the original work
- Serve as final reviewer prior to release of project information
- Approve and sign outgoing correspondence
- Determination of the length of time for sample storage, if different than standard IT requirements.

Specific responsibilities may be assigned by the Project Managers to members of the Project Staff.

2.3 LABORATORY PERSONNEL

Within IT, laboratories are associated with IT Environmental Projects Group Analytical Services (ITAS). Comprehensive chemical and geotechnical analyses are performed by ITAS. Fundamental chemical analyses, such as pH and dissolved oxygen, may be performed by an office as part of its field investigations. The following discussion considers the work performed by ITAS, where ITAS acts as an adjunct to the project group.

To provide a complete discussion of the Quality Assurance practices for a engineering project, the quality-related activities of ITAS are presented. The information is abstracted from the ITAS Quality Assurance Manual considering the typical engineering project (as shown in Figure 1-1), so that engineering personnel are aware of the Quality Assurance responsibilities of the laboratories.

ITAS is the responsibility of the Vice President, Analytical Services as shown in Figure 2-1. This Vice President is responsible for all activities performed in ITAS laboratories, parallel to the overall engineering responsibilities of the Regional Directors, Engineering Operations. On a day-to-day basis these responsibilities are assigned to the individual Laboratory Managers. The quality-related duties of the Laboratory Manager, and the Technical Director who substantively affect resulting data quality are:

- Laboratory Manager
  - Implement the ITAS Quality Assurance Program within the laboratory
  - Periodically determine effectiveness of the Quality Assurance Program in the laboratory
  - Supervise Quality Control activities
  - Approve Laboratory-Specific Attachments to the Quality Assurance Manual and Project-Specific Manuals and revisions
  - Recommend to the ITAS Quality Assurance Manager changes in the laboratory Quality Assurance Program
  - Maintain current distribution lists for Laboratory-Specific Attachments and Project-Specific Manuals
  - Review and approve Quality Assurance Project Plans, as appropriate
  - Approve reports issued by the laboratory
  - Serve as the "focal point" for the reporting and disposition of laboratory nonconformances
  - Maintain current laboratory organization chart.
- Technical Director
  - Provide technical overview of laboratory activities
  - Serve as an "in-house" consultant for the applicability of general Quality Control practices to specific needs

- Review statistical data to verify the laboratory is meeting stated Quality Control goals
- Evaluate new analytical techniques, procedures instrumentation and Quality Control methods, and provide recommendations to the Laboratory Manager
- Verify software for data processing and data management
- Recommend standards for purchasing instrumentation, equipment, reagents, gases, chemicals, etc.
- Supervise laboratory participation in interlaboratory accreditation and proficiency programs
- Define calibration program within the laboratory.

The quality-related duties of Laboratory Manager parallel those of the Project Manager. Duties of the laboratory Technical Director parallel the project positions of Technical Advisor and Principal Investigator.

2.4 QUALITY ASSURANCE PERSONNEL

Within IT are personnel primarily devoted to the development and implementation of Quality Assurance practices. The duties of each as they pertain to Engineering Operations follow.

2.4.1 Engineering Operations

2.4.1.1 Regional Quality Assurance Managers

Each Regional Director has the option of appointing a Regional Quality Assurance Manager. The Regional Quality Assurance Manager is responsible to the individual directing the specific Engineering Operations Region as illustrated in Figure 2-1. The Regional Quality Assurance Manager is responsible for implementing the engineering Quality Assurance Program within a region. The concept of the Regional Quality Assurance Manager is to provide a region with an experienced person knowledgeable with the IT Engineering

Operations Quality Assurance Program. In general, the Regional Quality Assurance Manager will provide guidance and direction to the Quality Assurance Officers within the region.

The responsibilities of the Regional Quality Assurance Manager are:

- Periodically, audit the engineering operations assigned to the region for compliance to the IT Engineering Operations Quality Assurance Program.
- Assist the Director, Quality Assurance and Discipline Management during the annual generic Quality Assurance Program compliance audits of the Engineering Operations offices/groups within the region.
- Verify completion of corrective actions cited in audits.
- Act as the collection point within a region for proposed changes in the Engineering Operations Quality Assurance Program.
- Assist the Quality Assurance Group in training Quality Assurance Officers.
- Perform project-specific audits if the Quality Assurance Officer is involved in the project as part of the Project Staff, or if the Quality Assurance Officer does not satisfy contractual or regulatory requirements for auditing.
- Provide direction for Quality Assurance activities to establish uniform quality practices, whenever possible, for similar work within the region.
- Approve Quality Assurance Project Plans if designated by the Director, Quality Assurance and Discipline Management.
- Approve corrective actions in response to project-specific audits, if this duty is delegated by the Director, Quality Assurance and Discipline Management.
- Serve as the Project Quality Assurance Review Committee or designate authority to the Quality Assurance Officer for representation.

- Submit monthly Regional Quality Assurance Activities Reports to the Director, Quality Assurance and Discipline Management.

The Regional Quality Assurance Manager may not:

- Establish technical procedures or Quality Assurance policies for a region which are not in accordance with the policies of this Manual without written permission of the Director, Quality Assurance and Discipline Management.

- Waive the policies of this Manual without written permission of the Director, Quality Assurance and Discipline Management.

2.4.1.2 Engineering Quality Assurance Officers

Each engineering office/group has a designated Quality Assurance Officer responsible to the individual directing that office/group as shown in Figure 2-1. The Quality Assurance Officer is responsible for implementing the engineering Quality Assurance Program within an office/group with particular emphasis on the fulfillment of daily Quality Control practices. The basic concept of the Quality Assurance Officer is to provide each office/group with a person knowledgeable with the Engineering Operations Quality Assurance Program, and who is an integral member of that office/group.

The Quality Assurance Officer will typically not be exclusively devoted to Quality Assurance activities, depending upon the needs of the particular office/group. If the Quality Assurance Officer works on a specific project as part of the Project Staff, Quality Assurance audits of those projects cannot be performed by the Quality Assurance Officer because of lack of independence.

Responsibilities of the Quality Assurance Officer are:

- Provide expertise for quality-related matters to an engineering office/group.

- Maintain a high level of quality awareness among the project staff through training, communication, and recognition programs.

- Implement and verify on a generic basis the provisions of this Quality Assurance Program. This includes verifying on an ongoing basis that calculations are properly prepared and reviewed and that the Office/Group Records Management System is maintained. The Quality Assurance Officer may also perform informal audits or spot checks of office activities.

- Train project personnel in their quality-related responsibilities. This training includes new employee, project-specific, and continuing Quality Assurance training.

- Review of projects during initiation to determine if the provisions of this Manual are sufficient to meet the project quality requirements. If additional quality practices are needed, the Quality Assurance Officer shall act as the project focal point for the preparation of additional/revised procedures.

- Preparation of project-specific Quality Assurance outlines and Project Quality Control documents.

- Preparation, or review and approval, of project-specific Quality Assurance Plans with particular emphasis on the inclusion of adequate means for satisfying project quality requirements.

- Preparation for an office/group, as-needed, quality-related procedures which supplement/amplify the provisions of this Manual because of the specific additional needs of that office/group.

- Review technical purchase order requisitions for inclusion of quality assurance requirements.

- Perform project-specific Quality Assurance audits

- Respond directly to the Director, Quality Assurance and Discipline Management or Regional Quality Assurance Manager, as appropriate, if nonconformances/corrective actions cannot be resolved through the Project Manager, Project Director, or Operations Manager. (In these cases the Director, Quality Assurance and Discipline

Management or Regional Quality Assurance Manager (at the Director's request), as appropriate, will discuss the issue with the Project Quality Assurance Review Committee.)

- Correspond on a regular basis with the Director, Quality Assurance and Discipline Management. This includes a monthly report listing the quality assurance activities, problems, and trends of the office.

The Quality Assurance Officer (or any member of an engineering office/group) may not:

- Establish technical procedures or Quality Assurance policies for an office/group or a specific project which are not in accordance with the policies of this Manual without written permission of the Director, Quality Assurance and Discipline Management.

- Waive the policies of this Manual (considering the requirements of the project quality level) without written permission of the Director, Quality Assurance and Discipline Management.

With regard to Quality Assurance audits, the following applies:

- The Quality Assurance Officer can perform independent audits of project activities providing the following are satisfied:

  - The Quality Assurance Officer has not participated in the project as a member of the Project Staff

  - The Quality Assurance Officer meets specific contractual or regulatory requirements for auditor qualification

- If both conditions can not be met, audits will be performed by the Regional Quality Assurance Manager, the Quality Assurance Officer of another office/group, or the Environmental Projects Quality Assurance Group

- Audits shall be conducted in accordance with the requirements of Section 11.0 of this Manual. All audit reports shall be submitted to the Director, Quality

Assurance and Discipline Management or the Regional Quality Assurance Manager, if designated this responsibility by the Director, for review.

If specific contractual or regulatory provisions require full independence of the Quality Assurance Officer from the office/group to which the Quality Assurance Officer is assigned, the Quality Assurance Officer shall report directly to the Director, Quality Assurance and Discipline Management or Regional Quality Assurance Manager, as appropriate, for that project. If the reassignment of reporting function for a specific project is still considered inadequate (because of the overall assignment of a Quality Assurance Officer to a specific office/group), Quality Assurance activities for the project, such as auditing, will be performed by the Environmental Projects Quality Assurance Group or the Regional Quality Assurance Manager, as appropriate.

2.4.2 Laboratory Quality Assurance Personnel

Because of the particular needs for Quality Assurance associated with laboratory operations, ITAS maintains a Quality Assurance Program dedicated to the analytical laboratories and Quality Assurance personnel to implement and administer the Program. The ITAS Quality Assurance Manager reports directly to the Vice President, Analytical Services, and is responsible for maintenance of the program and overall implementation. Within each laboratory, a Quality Control Coordinator is responsible for the day-to-day implementation of the Quality Assurance Program. Similar to the reporting function of the Quality Assurance Officer, the Quality Control Coordinator is part of the individual laboratory organization. The quality-related responsibilities of the ITAS Quality Assurance Manager and Quality Control Coordinators are:

- ITAS Quality Assurance Manager
  - Approve all ITAS Quality Assurance documents
  - Audit ITAS laboratories for compliance to the ITAS Quality Assurance Program

- Verify completion of corrective actions cited in audits

- Act as the collection point for proposed changes in the ITAS Quality Assurance Program and initiate program changes

- Approve Laboratory - specific attachments to the ITAS Quality Assurance Manual

• Quality Control Coordinator

- Supervise the log in of all samples received, complete chain of custody, and maintain sample logbooks

- Prepare Quality Control standards, insert Quality Control samples into the laboratory sample stream, and analyze results

- Perform statistical analyses utilizing results of Quality Control sample analyses

- Inform the Laboratory Manager and Group Leaders of data which lie outside of acceptable limits

- Notify the Technical Director, Project Manager, and Laboratory Manager, as required, of nonconformances

- Report nonconformances to the ITAS Quality Assurance Manager if the situation is not corrected within the laboratory

- Assist in the performance of Quality Assurance audits and perform Quality Control audits

- Train analysts in Quality Control procedures

- Oversee instrument, calibration, and preventive maintenance schedule.

2.4.3 Projects Management Quality Assurance Officers

Projects Management Quality Assurance Officers are appointed on a project basis and are responsible to the Project Manager. The Quality Assurance Officer is responsible for implementing the Projects Management Quality

Assurance Program within a project with particular emphasis on the fulfillment of daily Quality Control practices. The basic concept of the Quality Assurance Officer is to provide a Projects Management project with a person knowledgeable with the Projects Management Quality Assurance Program, and who is an integral member of that project.

The Quality Assurance Officer typically may not be exclusively devoted to Quality Assurance activities depending upon the needs of the particular project. It is possible that the Project Manager may serve as the Quality Assurance Officer in addition to other duties. The Quality Assurance Officer will not be able to perform Quality Assurance audits of the assigned project because of a lack of independence. The Director, Quality Assurance and Discipline Management, or a member of staff, will perform the Quality Assurance audits of this project.

The responsibilities of the Projects Management Quality Assurance Officer are:

- Provide expertise for quality-related matters for a project.
- Implement the provisions of the Quality Assurance Program for the assigned project. This includes verifying on an ongoing basis that daily logs are prepared and calculations are properly prepared and reviewed and that the Project Records Management System is maintained.
- Review technical purchase orders for inclusion of quality and technical requirements.
- Train project personnel in their quality-related responsibilities.
- Review of assigned projects during initiation to determine if quality-related provisions are sufficient to meet the project quality requirements. If additional quality practices are needed, the Quality Assurance Officer shall act as the focal point for the preparation of additional/revised procedures.

- Preparation of project-specific Quality Assurance outlines and project Quality Control documents.

- Preparation and review of project-specific Quality Assurance Plans with particular emphasis on the inclusion of adequate means for satisfying project quality requirements.

- Communicate directly with the Director, Quality Assurance and Discipline Management, or staff on matters of Quality Assurance.

The Projects Management Quality Assurance Officer may not:

- Establish technical procedures or Quality Assurance policies for a specific project which are not in accordance with the policies of this Manual without the written permission of the Director, Quality Assurance and Discipline Management.

- Waive the policies of this Manual (considering the requirements of the project quality level) without written permission of the Director, Quality Assurance and Discipline Management.

If specific contractual or regulatory provisions require full independence of the Quality Assurance Officer from the project management to which the Quality Assurance Officer is assigned, the Director, Quality Assurance and Discipline Management, a member of staff, or designated independent individual shall assume the duties of the Quality Assurance Officer.

2.4.4 Manufacturing Quality Assurance Personnel

Because of the particular needs for Quality Assurance and Quality Control associated with the manufacturing operations, Environmental Products Division (EPD) maintains a Quality Assurance Program dedicated to the design and manufacture of environmental management equipment and Quality Assurance personnel to implement and administer the Program. The Environmental Products Division Quality Assurance personnel report directly to the Director, Products Division. The quality-related responsibilities of the Environmental Products Division Quality Assurance personnel are:

- Approve all EPD Quality Assurance documents
- Perform quality control inspection of products
- Audit EPD manufacturing operations for compliance to the EPD Quality Assurance Program
- Verify completion of corrective actions cited in audits
- Audit specific projects for compliance to project-specific quality assurance requirements, including national code and regulatory requirements
- Act as the collection point for proposed changes in the EPD Quality Assurance Program and initiate program changes
- Train manufacturing personnel in their quality-related responsibilities
- Review technical purchase order requisitions for inclusion of quality assurance requirements
- Respond directly to the Director, Quality Assurance and Discipline Management if nonconformances/corrective actions cannot be resolved through the Director, Products Division.

2.4.5 Environmental Projects Quality Assurance Group

The functions of the Environmental Projects Quality Assurance Group (Figure 2-1) and the responsibilities of the Director, Quality Assurance and Discipline Management are:

- Establish requirements and policies throughout the Environmental Projects Group for general Quality Assurance activities such as verification, records preparation, and records management
- Provide direction for all Quality Assurance activities in the Environmental Projects Group to establish uniform quality practices whenever possible for similar work performed by different service groups (such as Engineering Operations and Analytical Services) and within a service group (such as different offices/groups within Engineering Operations).

- Verify that regulatory requirements for Quality Assurance are documented and implemented, as appropriate, for various groups

- Approve Quality Assurance Programs developed by specific groups

- Exercise stop work authority on a project, if in the opinion of the Director, Quality Assurance and Discipline Management operations require correction before work proceeds.

With regards to the Quality Assurance Program for engineering operations, the Director, Quality Assurance and Discipline Management will:

- Approve this Manual and revisions for use and other Quality Assurance documents as stated in Section 3.0.

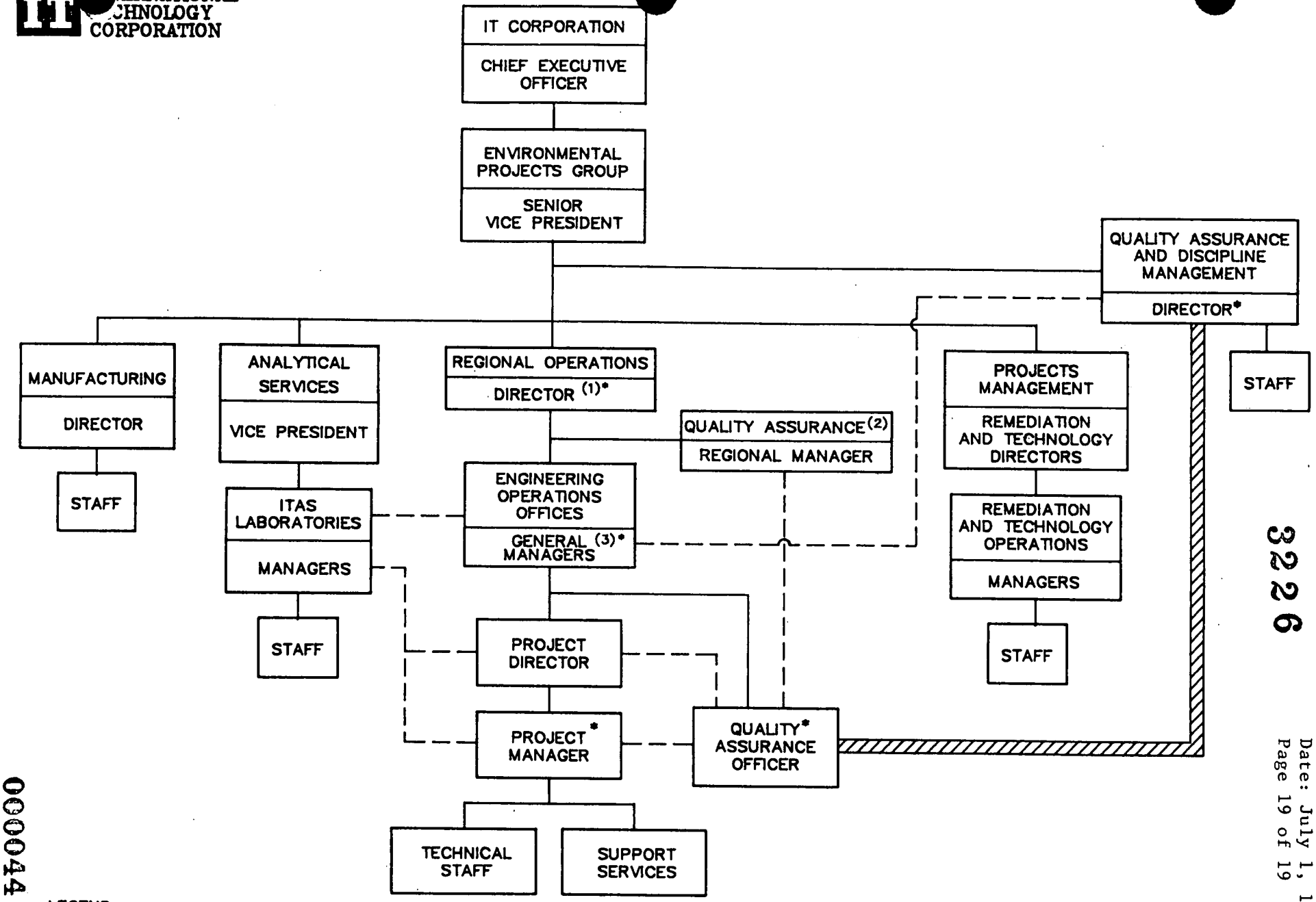
- Train Quality Assurance Officers.

- Audit engineering offices/groups for implementation of this Manual.

- Serve on the Project Quality Assurance Review Committee for specific projects or designate authority for representation. As part of the participation in the Review Committee, if resolution of a nonconformance or the result of an audit report cannot be reached by the Committee to the satisfaction of the Director, the Director shall notify the Senior Vice President, Environmental Projects Group. The Director will seek resolution with the Senior Vice President. The decision of the Senior Vice President is final and binding on all parties.

- Perform project-specific audits if the Quality Assurance Officer and Regional Quality Assurance Manager are involved in the project as part of the Project Staff, or if the Quality Assurance Officer does not satisfy contractual or regulatory requirements for auditing.

- Approve project-specific Quality Assurance Plans or appoint reviewer for an office/group.



LEGEND:

- * MEMBER OF PROJECT QA REVIEW COMMITTEE
- (1) MAY BE A REGIONAL OPERATIONS DIRECTOR OR REGIONAL VICE PRESIDENT
- (2) POSITION OPTIONAL AT DISCRETION OF REGIONAL OPERATIONS DIRECTOR
- (3) MAY BE GENERAL MANAGER OR MANAGER

DIRECT LINE OF RESPONSIBILITY

LINE OF COMMUNICATION

INDICATES DIRECT COMMUNICATION FOR DEFINITION OF POLICY OR DIRECT REPORTING IF REQUIRED BY REGULATION

FIGURE 2–1

ORGANIZATION OF ENGINEERING OPERATIONS

3.0 QUALITY ASSURANCE DOCUMENTS

This Quality Assurance Manual is the governing document and provides the overall Quality Assurance policy for Engineering Operations. Other Quality Assurance documents may be required to provide supplementary information for an office/group or project-specific requirements. This section discusses the types of Quality Assurance documents and their preparation and control.

3.1 TYPES OF DOCUMENTS

Quality Assurance document types are discussed below. Figure 3-1 highlights the basic purpose of each document.

- Quality Assurance Manual - The Engineering Operations Quality Assurance Manual provides the IT Quality Assurance Program for all Engineering Operations. The Manual discusses both administrative and technical aspects for the overall Quality Assurance system and basic Quality Control practices. The Manual is not intended to provide in-depth technical discussion. The Quality Assurance Manual has precedence in policy matters over all other IT Quality Assurance documents discussed herein with the exception of project-specific Quality Assurance Project Plans. If required for a specific project by contractual or regulatory requirements, provisions of the Quality Assurance Manual may be supplemented and/or amended providing the approvals required in Section 3.3.1 are obtained.

- Region/Office/Group-Specific Procedures - Provisions are made in the Quality Assurance Program to allow Region/Office/Group-Specific Procedures if:

  - The region/office/group provides a service which is unique in IT Engineering Operations and, as such, necessary Quality Assurance practices are not adequately discussed in this Manual; or because of the unique service, specific regulatory Quality Assurance controls are not included in this Manual

  - A region/office/group wishes to adopt supplementary procedures to amplify discussions in this Manual so that implementation is more readily facilitated. This could include specific instructions for records submittal and maintenance.

Specific procedures must be reviewed and approved for use as described in Section 3.3.1.

It is noted that a primary consideration of the Engineering Operations Quality Assurance Program is to promote uniform practices throughout all Engineering Operations. Therefore, the provision for the adoption of Office/Group-Specific Procedures is not to be used as a general mechanism for individually altering the provisions of this Manual. Only in unusual case-by-case circumstances will specific procedures which alter the provisions of this Manual be approved.

Because of intended need and usage of Region/Office/Group-Specific Procedures, specific procedures will be implemented with the same considerations for required usage as this Manual.

Basically, the Quality Assurance Manual provides policy which must be implemented. Procedures are meant to be approved supplements or changes to the Manual which provide additional information regarding implementation.

- Manuals of Practice - Manuals of Practice are developed to provide in-depth technical discussions of specific topics. Included could be manuals for geotechnical drilling, field sampling, and computer usage. These manuals are intended for use throughout the Environmental Projects Group so that uniform technical practice is established.

- Project-Specific Documents - Specific contractual or regulatory demands, or the uniqueness of a project's scope of work, may require the preparation and implementation of project-specific Quality Assurance documents. Project demands can include:

  - The revision of existing procedures and/or the development of new methods

  - Different project requirements than provided in this Manual for activities such as data reporting, equipment operation, or data processing

- Specific provisions for the maintenance of records

- Regulatory agency requirements for specific actions not included in this Manual

There are many types of project-specific documents such as test plans, overall work plans, sampling protocols, Quality Assurance Project Plans, Project Quality Control Documents, and Quality Assurance outlines. The documents which directly bear upon the implementation of the Quality Assurance Program are discussed below. Other documents such as test plans, work plans, and sampling protocols are discussed in Section 3.2.

- Quality Assurance Outline - as defined in Section 4.2, Quality Level I is the level routinely adopted for engineering projects. If Quality Level II is required by contract or regulations, or is selected for internal reasons, the Quality Assurance Officer shall prepare a Quality Assurance Outline as a project planning tool. The outline shall indicate the Quality Assurance activities above Level I which will be instituted for the project and the means for implementation. A preliminary audit schedule shall also be included.

  The requirement for the preparation of a separate Quality Assurance Outline document is waived when a Quality Assurance Project Plan is prepared.

- Project Quality Control Document - If basic Quality Control practices (Level I) are increased or conventional Quality Control practices are amended for a specific project, a Project Quality Control document shall be prepared by the Quality Assurance Officer and the Project Manager and distributed to the Project Staff. The Quality Control document shall indicate the practices to be revised, and the implemented changes. This document is intended to indicate only changes from established practice. It is not intended to discuss complete project Quality Assurance practices.

- Quality Assurance Project Plans - Quality Assurance Project Plans are a comprehensive statement of the Quality Assurance practices to be implemented for a specific project. Generally, they include the quality objectives for a project (such as needed data

accuracy and precision), the means for work performance which are expected to meet these objectives, and a means for determining whether or not the objectives have been met. Such plans are generally prepared due to specific regulatory or contractual demands.

Quality Assurance Project Plans are a total statement of the quality-related practices which IT will implement for the specific project. The Plans represent the Quality Assurance Program for the project and take precedence over the Quality Assurance Program presented in this Manual or other IT Quality Assurance documents.

In preparing Quality Assurance Project Plans, the requirements of regulation and/or contract must be met. However, in general, such plans shall not be used as a means for reducing the basic Level I or Level II quality requirements of this Manual, or the provisions of other IT Quality Assurance documents. If IT requirements exceed demands of the project, IT practices shall be used unless the requirements of the project contract specifically designate less stringent policies.

Quality Assurance Project Plans may be prepared by any member of the Project Staff; however, it is recommended that the Quality Assurance Officer participate in the preparation, particularly with regard to the inclusion of appropriate Quality Assurance practices. If the Quality Assurance Officer does not participate in plan preparation, the Quality Assurance Officer shall review and approve the plan prior to other approvals.

- Quality Assurance Program Plans - Quality Assurance Program Plans are a generalized statement of the Quality Assurance practices to be implemented for a client's specific program. Individual Quality Assurance Project Plans may be prepared under the guidance of the Quality Assurance Program Plan for specific projects within a program. The Quality Assurance Program Plans may include the quality objectives for a project (such as needed data accuracy and precision), the means for work performance which are expected to meet these objectives, and a means for determining whether or

not the objectives have been met. Quality Assurance Program Plans are generally prepared due to specific regulatory or contractual demands.

Unlike the Quality Assurance Project Plans, the Quality Assurance Program Plans are not a total statement of the quality-related practices. The Quality Assurance Program Plan will be supplemented with Quality Assurance Project Plans and standard and project-specific operating procedures. The guidance found in the Quality Assurance Program Plan will take precedence over the Engineering Operations Quality Assurance Program presented in this Manual or other IT Quality Assurance documents.

The provision for meeting contractual and regulatory requirements described above for Quality Assurance Project Plans apply also to the Quality Assurance Program Plans.

Quality Assurance Program Plans may be prepared by any member of the Project Staff; however, it is recommended that the Quality Assurance Officer participate in the preparation, particularly with regard to the inclusion of appropriate Quality Assurance Practices. If the Quality Assurance Officer does not participate in plan preparation, the Quality Assurance Officer shall review and approve the plan prior to other approvals.

3.2 PROJECT PROCEDURES

In addition to the Quality Assurance documents discussed in Section 3.1, project-specific procedures are frequently prepared to describe the means for performing the project, or specific aspects of a project. These procedures are generally referred to as test plans, work plans, sampling protocols, etc. and can be used to provide guidance for any quality-related activity. For example, procedures may:

- Specify where samples will be taken, the means for collection, preservation, and shipment
- Provide instructions for the operation of specialized equipment

- Describe the computational method to be used for the reduction and processing of data
- Provide computational methods for performing engineering/scientific calculations.

In some instances, the technical proposal may be used as a work plan, provided it meets the requirements for content, described below, and review, described in Section 3.3.1.

Procedures shall include, as appropriate:

- Objective - Need for the procedure and goals of the activity
- Scope - Activity described in the procedure
- Method - Work and/or test methods to be used and sequential actions required by the method
- Required Equipment - Instruments, tools, and equipment needed to perform the activity
- Calibration Requirements - Identification of equipment which must be calibrated as part of the activity, required performance, and the means for calibration and recording the calibration data
- Required Materials - Specific materials needed, including sample containers and preservatives
- Personnel Qualifications - Required education, training, and/or certification of personnel
- Subcontractor Services - Activities to be performed by subcontractors to IT and the means for evaluating performance
- Performance Recording Form/Format - Samples of forms and/or outline of the format required for the acquisition and recording of data
- Required Inspection - Schedule and scope of inspections that must be completed before work continues

- Data Processing Requirements - Method for reduction of data and requirements for verification of the reduction
- Accept/Reject Criteria - Criteria for determining satisfactory completion
- Performance Frequency - Interval for performance such as based on depth, time, etc.
- Required Analyses - Interpretations, judgments, and calculations required
- Documentation and Reporting Requirements - Required documentation of equipment calibration, performance, data acquisition, data reduction, inspection, and analyses.

Whenever possible, widely accepted methods, such as those published by the American Society for Testing and Materials (ASTM), the American Standards Institute (ANSI), or the U.S. EPA, shall be used in developing procedures.

The review and approval required for procedures shall depend upon the extent of their usage as discussed in Section 3.3.

3.3 DOCUMENT CONTROL

This Quality Assurance Manual, Region/Office/Group-Specific Procedures, and Manuals of Practice are controlled documents. Project-specific documents, such as Quality Assurance Project Plans and procedures, may be formally controlled if required by regulatory or contractual requirements. The requirements for approval and mechanisms for control follow.

3.3.1 Review and Approval of Documents

Prior to use, the following documents must be reviewed and approved by:

- IT Environmental Projects Group Engineering Operations Quality Assurance Manual

  - Senior Vice President, Environmental Projects Group

- Director, Quality Assurance and Discipline Management

- Region/Office/Group-Specific Procedures
  - Regional Director, if a Regional Procedure
  - Operations Manager, if an Office/Group Procedure
  - Director, Quality Assurance and Discipline Management
  - Regional Quality Assurance Manager
  - Quality Assurance Officer, if not prepared by this individual

- Manuals of Practice
  - Senior Vice President, Environmental Projects Group
  - Director, Quality Assurance and Discipline Management

- Project-Specific Documents
  - Quality Assurance Outline
    - Operations Manager
    - Director, Quality Assurance and Discipline Management or, if designated, the Regional Quality Assurance Manager or Quality Assurance Officer
  - Project Quality Control Document
    - Operations Manager
    - Director, Quality Assurance and Discipline Management or, if designated, the Regional Quality Assurance Manager or Quality Assurance Officer
  - Quality Assurance Project Plans and Quality Assurance Program Plans
    - Quality Assurance Officer (if not prepared by Quality Assurance Officer)
    - Operations Manager

- ITAS Laboratory Manager (for projects that involve analytical activities)
- Project Manager
- Director, Quality Assurance and Discipline Management or, if designated, the Regional Quality Assurance Manager or Quality Assurance Officer

- Project-Specific Procedures, such as work plans, sampling protocols, etc.

  - Operations Manager
  - Quality Assurance Officer
  - Project Manager.

Approval of the above documents shall be denoted by a signature and date page in each document which indicates the above approvals and the document author. Approval signatures required from clients and/or regulatory agencies shall also be included. As an alternate, signatures can be included on the document title page.

3.3.2 Distribution

In general, documents will be distributed as needed to IT personnel. When a document is no longer needed or an IT copyholder leaves IT it shall be returned to the issuing group. All copies of controlled documents will be numbered for document control. Distribution of this Quality Assurance Manual and the Manuals of Practice will be by the Director, Quality Assurance and Discipline Management. Region/Office/Group-Specific Procedures shall be distributed by the respective Quality Assurance Officer or Regional Quality Assurance Manager. For controlled project-specific documents, the Quality Assurance Officer shall control distribution of all quality-related documents and the Project Manager shall distribute all procedures. Distribution lists will be maintained by the Director, Quality Assurance and Discipline Management, and the appropriate Quality Assurance Officer or Regional Quality Assurance Manager for the manuals respectively controlled.

Copies of Quality Assurance documents will be issued external to IT as required and in the case of the Quality Assurance Manual and Manuals of Practice, the recipient will be notified of the proprietary nature of the document. These documents may be controlled (numbered) or uncontrolled (uncontrolled, and so marked) depending upon the reason for issue. Controlled copies will be revised in accordance with the above. External parties will be asked to return Quality Assurance documents when their need has ended.

3.3.3 Revision of Documents

Whenever the documents cited in Section 3.3.1 are revised, review and approval of the revision shall be in accordance with the requirements of the original document.

Revisions shall be issued to all copyholders of record. Each copyholder will sign a revision receipt verifying that the revision has been received and properly placed in the document. The receipt will be returned to the issuing individual.

Revisions to documents shall, as a minimum, be denoted by including the consecutive revision number on the document title page, revised signature page, and each page that has been revised. For the Quality Assurance Manual and the Manuals of Practice, the following shall be identified on each page to facilitate revisions:

Section No._____
Revision No._____
Date: (of issue)
Page __ of __

The page numbers are to be inclusive for each manual section.

For other controlled documents, the above system may be used, or as a minimum the revision number and date of revision shall be indicated on each revised page. Only pages which are revised need to be reissued.

DOCUMENT	PURPOSE
Quality Assurance Manual	• Establishes IT policy for engineering operations • States responsibilities of personnel • Describes basic Quality Control practices
Region/Office/Group-Specific Procedures	• Provide supplementary Quality Assurance practices for a specific region/office/group • For specific region office/group becomes a supplement to or incorporated in the Quality Assurance Manual
Manuals of Practice	• Detailed discussion of specific technical subjects • Incorporated as an approved manual for use throughout the Environmental Projects Group
Project-Specific Documents	• Prepared as required by specific contract to meet contractual or regulatory requirements • May supplement or change Quality Assurance policies and/or practices for a specific project

FIGURE 3-1

ENGINEERING OPERATIONS QUALITY ASSURANCE DOCUMENTS

4.0 PROJECT PLANNING

This section presents quality-related activities that are appropriate during the project planning stage (as shown in Figure 1-1). This section also includes a discussion of proposal preparation as part of project planning. The selection of activities for implementation, and needed degree of implementation, is dependent upon the needs of the specific project. The means for implementing several topics are included.

4.1 PROJECT PREPARATION

The Quality Assurance activities required during a project must be determined and implemented during the planning stage of a project. Quality must be "built-in" from the beginning. Several key decisions should be made during planning, the first being the selection of quality level as discussed in Section 4.2.

However, defining the quality level and considering the other aspects presented in the remainder of the Manual, does not provide all of the detail needed to plan the project. Questions of specific actions to be taken during the project must be addressed. Following are typical questions that should be asked during planning. The list is representative, not inclusive:

- What is the problem? Why is IT involved?
- What do we need to know about the site, or problem?
  - Contaminants present
  - Identification and extent of contaminants
  - Ground water regime
  - Sources of fine-grained material
  - Means for in situ or on-site treatment
  - Potential for concentrating contaminants for off-site disposal or treatment

- What is the end product of our work?
  - Preparation of a regulatory submittal
  - Report to client characterizing the site and/or containing recommendations for remediation
  - Report presenting designs or results of technology development
  - Specifications/drawings for direct implementation of remediation
- How can we determine the data we need to know?
  - Collection and analysis of samples
  - Bench scale prototype testing
  - Geophysical surveys
  - Theoretical modeling
- If data is needed, what kind of samples do we need; how are the samples obtained; how will samples be analyzed?
- Do we have the equipment and materials required?
- Do we have needed data sheets; should they be changed or new ones prepared?
- What will the data be used for?
  - Baseline site characterization
  - Ongoing monitoring to verify regulatory compliance
  - Remedial design and construction
  - Litigation
- How "good" must the data be?
  - Are there regulatory criteria?
  - What accuracy and precision are required?

- What are the capabilities of existing analytical procedures?

- What is IT's exposure?
  - Are we developing criteria or implementing criteria development by others (including regulation)?
  - Are we originating design/remediation?
  - Is it expected that we will be required to demonstrate our performance through documentation?
- Who will do the work; are qualified people in IT; are they available?
- What controls are needed for subcontractor services?
- Do we have needed computer software; has it been documented and verified?
- Is peer review planned; who will do it; are they available?
- Finally, has planning addressed the proposal prepared by IT, and included contractural/regulatory demands? Does planning provide the means for satisfying our contract?

4.2 SELECTION OF QUALITY LEVEL

Two levels of application of the Quality Assurance Program are defined for use in engineering projects. For each project, the Project Quality Assurance Review Committee (Section 2.1) shall select (or Level I shall apply by default) the quality level which will provide appropriate data, results, and documentation for the objectives of the project. The two quality levels are:

- Level I - The "standard" IT quality requirements are applied. There is minimal involvement of Quality Assurance personnel during the course of work, generally auditing is not performed
- Level II - The maximum application of Quality Assurance practices and substantial participation of Quality Assurance personnel.

As previously stated in Sections 2.0 and 3.0, Level I is the "standard" application for IT engineering projects. If the Project Quality Assurance Review Committee does not select a different level, Level I shall be applied. If Level II is selected, a specific implementing Quality Assurance Outline must be prepared by the Quality Assurance Officer unless a Quality Assurance Project Plan is prepared (Section 3.1).

The level selected defines the intensity of application of Quality Assurance functions. Typical functions for each level are shown in Tables 4-1 and 4-2. In these tables, Quality Control functions are considered to be routine project practices, Quality Assurance functions are additional verification and demonstration functions. As can be seen, the major difference between Levels I and II is the required formal audits.

The level selection process should occur during the project proposal preparation stage so that the cost of implementation and schedule considerations can be included. At the latest, the selection shall be made during the planning stage of a project. The level selection should be documented by a memorandum to the file stating the project quality level selected. It should be signed by all members of the Project Quality Assurance Review Committee.

To select a project quality level, the following points shall be evaluated:

- Institutional needs that control the end use of project information and results (i.e., what must the project satisfy?)
- Criteria which govern the performance of the project (such as regulations, contract requirements, and IT policies)
- State of knowledge necessary to satisfactorily complete the project (i.e., what is the degree of technology required?)
- Project complexity.

Figure 4-1 presents these points in the framework of a decision tree so that the project quality level can be determined.

The starting point in the decision tree is defined by a general review of project objectives. If the performance of project activities and end use of data and results are controlled by government regulations or expected legal action, the REGULATIONS/LEGAL ACTION category shall be utilized. Regulations promulgated by the USNRC mandate the adoption of Level II with a full Quality Assurance Program for projects regulated by USNRC. In a similar fashion, federal (e.g., U.S. EPA) and state environmental agencies often mandate through their regulations the use of a formal Quality Assurance Program for a project, so that Level II implementation is appropriate. Projects controlled by consent decrees or impending legal proceedings should be considered for Level II implementation because of the expected need to demonstrate performance.

If a project does not fall into the REGULATIONS/LEGAL ACTION category, the CLIENT NEEDS/CONTRACT REQUIREMENTS category shall be considered. Within this category, project control is largely dictated by specific needs, requirements, and/or specifications documented or referenced in procurement documents. As seen in Figure 4-1, several quality levels may be selected.

If neither of the first two categories in the decision tree are appropriate, the IT NEEDS category shall be used as the starting point. The project control needed is a function of the expected magnitude of IT liability, industry, or public exposure; the future technical use of data generated; and the objectives of a research and development effort. In addition, the Project Quality Assurance Review Committee or other IT management may require Level II commitment (e.g., formal audits) in any project to serve as a management review tool.

Once the appropriate decision tree control category has been determined, the degree of technology required to satisfactorily complete a project shall be defined. For the purpose of selecting a quality level, project technology shall be considered as SOPHISTICATED or ROUTINE. SOPHISTICATED implies "state of knowledge" (extending the forefront of knowledge) or "state of the art" (at the forefront of knowledge) technologies. ROUTINE implies activities which may be completed using normal professional practices. Table 4-3 lists typical project elements which can influence the required degree of technology.

The final determination which must be made prior to selection of the project quality level is the degree of project complexity. The decision tree permits classification as either HIGH or LOW. To assist in this classification, Table 4-4 provides a series of typical questions, the answers to which define project complexity. For each specific project, additional questions may be appropriate.

By evaluating each of the points (i.e.; control, technology, and complexity) as outlined above and by using the results of the evaluations to define a path through the decision tree of Figure 4-1, the recommended level of project quality can be selected. If more than one path appears possible for a particular project, the highest quality level determined is recommended for that project. If a dual quality level is determined (e.g., Level I-II), the Project Quality Assurance Review Committee shall decide which level is to be used.

If the project is amended from Level I practice, the following courses of action shall be taken:

- If the project is to be conducted at Quality Level II, the appropriate Quality Assurance Officer shall prepare a Quality Assurance Outline or Quality Assurance Project Plan (Section 3.1) for the project listing all Quality Assurance activities which exceed Level I and the means for implementation. This could include preparation of work plans, project-specific Quality

Assurance plans, audits to be performed, and formal subcontracting practices. The outline on a Quality Assurance Project Plan shall be reviewed and approved by the Director, Quality Assurance and Discipline Management.

- If Level I practices must be increased, the appropriate Quality Assurance Officer shall prepare, in concert with the Project Manager, a Project Quality Control document for distribution to the affected Project Staff stating the changes. The document shall be approved as discussed in Section 3.3.1.

- Work plans, sampling protocols, and Quality Assurance plans, developed for a specific project, shall be approved as discussed in Section 3.3.1.

- Regulatory and client requirements which affect established Quality Assurance practices shall be discussed by the Project Quality Assurance Reveiw Committee and addressed in the form of the documents discussed above.

- If a nonconformance is not resolved to the satisfaction of the appropriate Quality Assurance Officer, the reporting and resolution mechanism presented in Section 8.0 shall be instituted.

- If a request for corrective action resulting from an audit is not adequately resolved, the reporting and resolution mechanism presented in Section 11.0 shall be instituted.

4.3 PERSONNEL TRAINING AND QUALIFICATION

All quality related activities performed by IT shall be accomplished by personnel qualified on the basis of education, experience, and training.

4.3.1 Project Staff Training

General training in the requirements of the Engineering Operations Quality Assurance Program is required of all technical engineering personnel. Formal training sessions will be conducted and documented by Quality Assurance personnel. The training program shall address: regulatory requirements (as appropriate); basic Quality Control practices, including checks and balances

inherent in the system; responsibilities of the Project Staff; responsibilities of Quality Assurance personnel; and the performance of audits.

New technical employees will be given training in Quality Assurance practices and policies. The training should take place soon after the new employee begins work at IT, preferably the first day of employment. It is the joint responsibility of the Operations Manager and the Quality Assurance Officer to implement this training. New employee training will be documented by the Quality Assurance Officer.

Quality Assurance training documentation will include the name(s) of those trained, date(s) of training, and topics covered in training. The documentation will be maintained in the office/group Quality Assurance file.

For projects requiring a departure from standard Quality Level I practices, the Project Manager is responsible for reviewing the revised practices with members of the Project Staff. At the request of the Project Manager, this will be done by the Quality Assurance Officer or senior members of the Project Staff. Project-specific reviews shall include contractual and regulatory requirements, amendments of standard practice adopted for the project, project-specific procedures, and project-specific Quality Assurance documents. As necessary, Quality Assurance documents will be issued to the Project Staff. The review will be documented by a memorandum to the project file. The documentation will include the date of the review, the topics discussed, and the names of the participating Project Staff.

Additional training shall be given in quarterly informal "brown-bag" seminars. The topics to be discussed at these sessions may include technical procedures or Quality Assurance/Quality Control issues pertinent to the particular Engineering Operations office staff.

4.3.2 Project Staff Qualifications

Project Staffs are primarily composed of professional personnel who are engineers or scientists. Such personnel shall be assigned duties within the capabilities of their education and experience by the Operations Manager or Project Manager. The Project Manager shall be appointed by the Operations Manager. Qualifications of all professional personnel shall be documented by resumes which include academic credentials, employment history, experience, and professional registrations. Resumes are maintained on a corporate-wide basis.

Technicians and support personnel performing a technical function for a project are qualified through experience which is indicated in their resumes. These personnel shall also be assigned by the Operations Manager or Project Manager based on their capabilities. Technicians and support personnel shall be supervised in their activities by experienced personnel until in the opinion of the Project Manager they are capable of independently performing their duties.

If subcontractors are used by IT on a project, the Project Manager is responsible for establishing necessary qualification of subcontractor personnel and verifying their capability. Qualifications shall be established in the procurement documents.

If a project requires personnel with specific certifications (such as engineering registration in a given state or technician certification by a state or national organization), personnel meeting the necessary qualifications will be provided by IT.

4.3.3 Quality Assurance Personnel, Training and Qualifications

Quality Assurance personnel qualifications shall be documented in resumes as for professional personnel.

All Quality Assurance Officers shall be trained by the Director, Quality Assurance and Discipline Management so that the Quality Assurance Officers are proficient in the requirements of the Engineering Operations Quality Assurance Program and its application. In addition, the Quality Assurance Officers must be knowledgeable of governing regulations. Training will emphasize the performance of audits and required reporting. The Director, Quality Assurance and Discipline Management will maintain documentation of the training.

If audits are required for projects governed by USNRC Quality Assurance requirements (10 CFR 50, Appendix B), lead auditors shall be qualified in accordance with ANSI NQA-1, Supplement 2S-3. Qualification shall be performed by the Director, Quality Assurance and Discipline Management.

The auditor responsible for conducting a Quality Assurance audit is designated the Lead Auditor. Lead Auditors shall have the expertise necessary to direct all phases of the audit as described in Section 11.0 of this Manual.

Lead Auditors for nuclear-related projects (10 CFR 50, Appendix B requirements applied) shall meet several training and experience requirements for certification, as outlined below. First, they shall obtain a minimum of ten credits using the certification system presented in ANSI NQA-1, Appendix 2A-3.

Lead Auditors shall be capable of communicating effectively, in writing and orally. In addition, Lead Auditors shall have participated in a minimum of five Quality Assurance audits within the three-year period immediately prior to initial certification. One of these audits shall have been for a nuclear-related project and must have taken place within the 12-month period prior to initial certification.

Finally, Lead Auditors must undertake and pass a formal examination. This examination may be either written or oral, and should cover applicable aspects of the IT Quality Assurance Program, regulatory requirements, and Quality

Assurance auditing. The Corporate Director, Quality Assurance and Discipline Management is responsible for preparing and administering the examination and evaluating examination results. Evidence of the examination shall be documented.

Continued proficiency of Lead Auditors shall be maintained through active participation in Quality Assurance audits and the preparation and review of Quality Assurance documents. Evaluation of Lead Auditor proficiency shall be conducted on a yearly basis by the Director, Quality Assurance and Discipline Management.

If a previously certified Lead Auditor fails to maintain proficiency for two consecutive years, formal requalification, by the Director, Quality Assurance and Discipline Management, shall be required. This requalification will consist of:

- Reexamination
- Satisfactory participation in at least one Quality Assurance audit of a nuclear-related project
- Additional training and/or experience as deemed necessary by the Director, Quality Assurance and Discipline Management.

Formal certification and the annual evaluation of nuclear Lead Auditors shall be documented and maintained by the Director, Quality Assurance and Discipline Management.

4.3.4 Subcontractor Personnel, Training and Qualifications

If specific qualifications are required of subcontractor personnel, it is the responsibility of the Project Manager to impose such qualification requirements upon the subcontractor through procurement documents, specifications, or other means, and to verify fulfillment. Necessary qualifications may be due to accepted standard of practice, regulation (such

as engineering registration), technician registration and/or certification, or craft requirements (such as welder certification).

As appropriate for a specific project, the Project Manager is responsible for the training of subcontractor personnel with regard to IT quality-related requirements and documenting this training.

4.4 PROCUREMENT

The control of procurement documents and resulting subcontractor furnished quality-related items and/or services shall be based on the effect an item or service will have on project requirements and needed results. Subcontractors may be required by IT for: the purpose of providing a service under direct IT supervision (such as drilling); or performing activities independent of IT (such as for specialty testing, supplying equipment, or detail design engineering). The degree of independence of the subcontractor's service must be considered in determining the procurement controls needed. As a general comment, the more independent a subcontractor is of IT supervision, the more stringent should be the Quality Assurance requirements placed upon them.

The procurement process shall be adequately documented. The documentation shall include, as appropriate:

- Requests for proposal
- Specifications and scopes of work
- Quotes (proposals) submitted by subcontractors
- Telephone conversation documentation
- Meeting notes
- Purchase order requisition
- Purchase orders
- Prequalification forms
- Bid reviews
- Bid comparisons
- Change order documentation.

4.4.1 Procurement Document Control

Procurement documents issued by IT; including bid requests, purchase orders, and contracts; shall be prepared, reviewed, and approved as a joint effort of Purchasing, Project, and Quality Assurance personnel. The extent of each group's involvement is a function of the particular project and the item or service procured. Determination of necessary involvement shall be made by the Project Manager. Project procurement documents require review and approval by the Quality Assurance Officer.

Changes in a procurement document shall be subject to the same degree of control as was utilized in the preparation of the original document.

4.4.1.1 Procurement Document Content

Procurement documents shall state applicable requirements for personnel qualification, technical performance, quality, acceptability, and documentation.

The documents shall, as appropriate, specify the following technical requirements:

- General requirements (scope of work)
- Pertinent codes and standards
- Material composition and/or physical and chemical requirements
- Quantity and scheduling requirements
- Work procedures
- Testing and calibration requirements
- Performance and/or accept/reject criteria
- Reporting requirements.

Procurement documents will specify the scope of work in sufficient detail so that it is reasonable to expect that confusion and misunderstandings are eliminated.

Technical requirements shall be included in the procurement documents or referenced to specific drawings, specifications, procedures, regulations, or codes (along with specific revision numbers and issue dates) that describe the items or services to be furnished.

Purchased items and services shall be controlled by invoking appropriate quality-related requirements and elements of the appropriate IT Quality Assurance Program in the procurement documents. The requirements which a subcontractor must satisfy will vary depending on the purpose of the procurement and the degree of subcontractor independence. IT's right to stop work for quality problems should be clearly stated.

The responsibility for compliance with applicable quality requirements and elements of the appropriate IT Quality Assurance Program can be delegated to the subcontractor in the procurement documents, or can be retained by IT. If the responsibility is delegated, the subcontractor must have a documented Quality Assurance Program suitable for the needs of the project. If responsibility for compliance is retained, IT shall use the procurement documents to "pass down" the performance of specific quality requirements to the subcontractor. The "pass down" provides appropriate requirements which can be met without requiring the subcontractor to have their own Quality Assurance Program. Subcontractors providing detail design or other engineering services to IT will be required to comply with applicable sections of this Quality Assurance Manual, especially Section 6.0 - Modeling and Design, or equivalent practices.

To verify acceptability, the procurement documents shall provide for IT access to subcontractors' facilities, work areas, and records for auditing and inspection. This may include prequalification (Section 11.1.1.4) and source (Section 11.1.1.5) audits by Quality Assurance personnel, a quality check by Project personnel prior to beginning work (Section 4.4.2.3), and inspections and tests by Project personnel during the performance of work.

Documentation required by IT to provide evidence that materials, equipment, and services are of specified quality shall be identified by the procurement documents. The right of IT to review and approve this documentation prior to acceptance of an item or service should be stated. Instructions for the preparation, control, retention, and disposition of documentation should also be included or referenced.

Required documentation can include:

- Quality Assurance Project Plan
- Procedures and drawings
- Equipment operating manuals
- Test and work plans and logs
- Test and analysis data, results, and verifications
- Calibration records
- Personnel qualifications
- Material certificates of conformance
- Nonconformance records
- Drawing and calculation checkprints
- Computer program verification records.

In addition to the above; subcontractor submittals of nonconformances, work progress, results, and other deliverables shall be specified in the procurement documents, as appropriate.

Finally, procurement documents shall require subcontractors to incorporate applicable requirements in subtier procurements.

4.4.1.2 Procurement Document Review and Approval

Procurement documents shall be reviewed to verify that applicable IT, regulatory, and client requirements (performance, quality, acceptability, and documentation) have been incorporated. The reviews shall also verify that changes in the documents, as a result of bid evaluations or precontract negotiations, have been made. Reviews of bid requests and purchase orders shall be performed prior to their release. Reviews of contracts shall be performed prior to contract award. Purchasing, Project, and Quality Assurance personnel shall

participate, as necessary. The Quality Assurance Officer will review all technical purchase order requisitions. Documentation of the review shall be by signing the document draft, or by signing a routing stamp on the document.

Contract and subcontractor service purchase order approval shall be indicated as required by IT purchasing policies. Bid requests shall be approved by the Project Manager and/or responsible Operations Manager or designated Project Director for a specific project. Copies of all contracts, bid requests, and purchase orders for project services and review copies shall be maintained as records for the project.

4.4.2 Control of Purchased Items and Services

The control of purchased items and services shall, as appropriate to the specific project and each individual procurement, include:

- Prequalification of subcontractor
- Bid evaluation
- Procurement source evaluation and selection
- Subcontractor performance verification.

Control is provided by Purchasing, Project, and Quality Assurance personnel. It shall be applied as necessary to verify that an item or service conforms with the procurement documents. Items which do not meet Quality Assurance requirements shall not be accepted.

4.4.2.1 Prequalification of Subcontractor

So that projects can progress in a timely manner, IT prequalifies potential subcontractors. As stated in the Policies and Procedures Manual, Section 7.0 - Subcontractor/Team Member Selection, the prequalification process allows IT to award subcontracts in a prompt and effective manner. The prequalification process does not replace prequalification or source audits. The prequalification process eliminates potential subcontractors that do not meet basic IT requirements.

The prequalification process involves the completion and return by a potential subcontractor of certain documents previously transmitted by the Purchasing Department. These documents include the Contractor Prequalification Questionnaire, Work Agreement, and General Safety Rules for Contractors.

The completed questionnaire provides information concerning the contractor's health and safety practices, background, insurance data , medical practices, accident history, and Quality Assurance Program. The completed questionnaire will be reviewed by the appropriate IT individuals such as members of the Purchasing, Health and Safety, and Quality Assurance staffs, to determine if the contractor meets minimum IT requirements.

4.4.2.2 Bid Evaluation

Subcontractor bids shall be reviewed for conformance with procurement document requirements. As appropriate, individuals qualified to evaluate technical considerations, quality and documentation requirements, and subcontractor personnel shall be used. Only bids from prequalified subcontractors shall be considered. Prequalification of subcontractors is discussed in Section 4.4.2.1.

Documentation of bid review shall be by signing the review copy or bid routing stamp.

4.4.2.3 Procurement Source Evaluation and Selection

Procurement source evaluation is performed to determine subcontractor capability. The evaluation shall include any or all of the following:

- Subcontractor's history and any previous IT experience with the subcontractor
- Subcontractor's current records (qualitative and quantitative information)

- Subcontractor's technical and quality capabilities through the performance of a formal prequalification audit (Section 11.1.1.4) of their facilities and personnel.

Resolution, or commitments to resolve unacceptable conditions resulting from procurement source evaluation, shall be obtained from the subcontractor prior to selection and contract award. Any subcontractor selected to provide items or services shall have acceptable qualifications and shall be capable of performing within the requirements of the procurement documents.

4.4.2.4 Subcontractor Performance Verification

To verify subcontractor conformance to procurement document requirements, IT shall, as necessary, perform field quality checks, perform inspections and quality tests, review subcontractor prepared documentation, and perform source audits (Section 11.1.1.5).

For field operations, IT Project personnel shall perform a quality check of a subcontractor prior to commencing work. The intention of this check is to determine that the subcontractor has fulfilled the procurement requirements necessary to begin their activities. The check shall include the type and condition of equipment, calibration of equipment, and qualifications of personnel. Calibration documentation and personal resumes shall be made available to IT if requested during the quality check. If requirements are not met, sufficient grounds for suspension of activities exist. Equipment and/or personnel which do not meet IT and project requirements shall not be used without correction to the satisfaction of the responsible IT Field Supervisor. The results of the quality check shall be documented in a memorandum by the IT Field Supervisor to the Project Manager.

If subcontractor services are used for laboratory analyses, the Project Manager shall consider the use of IT submitted proficiency samples as a means for

the subcontractor to demonstrate capability. As an alternate, the participation of a subcontract laboratory in recognized proficiency programs shall be reviewed. In addition, the Project Manager shall obtain the approval of the Environmental Projects Group Analytical Services management prior to utilizing a subcontractor laboratory.

Source audits of subcontractor activities in the field, plant, laboratory, and/or office shall be performed and documented in accordance with Sections 11.2 and 11.3, respectively. The audits shall be conducted by Quality Assurance personnel. Objective evidence of conformance to procurement document requirements shall be thoroughly reviewed.

If subcontractor activities require the submittal to IT of documents such as instrument performance, material certifications, test results, etc., the Project Manager is responsible for obtaining the documents prior to the subcontractor's work being closed.

4.5 PEER REVIEW

This Quality Assurance Program provides controls for the formal verification (checking) of documents such as calculations and the presentation of information in the form of drawings, logs, and tables. Review and necessary approvals are also cited for quality related documents. However, quite often during the course of a project or proposal, verification of technical decisions and concepts such as interpretation of data and the evaluation of results is required so that the project or proposal can proceed on a sound conceptual basis. The review of concept, or approach, may be needed for the following:

- During the planning stage have appropriate steps been taken to meet the goals of the project? This could include:

  - Does the sampling plan provide for the number, type, volume, etc. of samples anticipated to provide needed data?

- Are analytical procedures adequate to provide data of sufficient detection, accuracy, precision, completeness for the project needs?

- Are appropriate computational methods to be used during design?

- Is data of sufficient quality and properly interpreted so that conclusions can be justified and demonstrated?

- If design parameters are assumed, are they reasonable for the computations performed? What is the effect of variation of the assumptions upon results?

- Do the results presented by IT in the format of a report, or other document (Section 9.3), adequately present the work performed and the conclusions reached? Do the results fulfill the objectives of the project?

The mechanism to be used in the Environmental Projects Engineering Operations for such verification is peer review.

The need for peer review is dependent upon the scope of the individual project. The Operations Manager and Project Manager shall determine during the planning stage of a project if peer review will be implemented, the points in the project when the review will be performed, and the individual(s) who will perform the review. The extent and importance of peer review for a specific project should be based on:

- Technical complexity of the work

- Experience of project personnel (peer review should also be a learning/teaching mechanism)

- Difficulty of implementing and fulfilling the methods/procedures to be used in the project

- Complexity of the logistics required to manage the project

- Effect upon project schedule and succeeding project stages if part of the work does not meet project goals so that either project goals/objectives must be revised or the work repeated

- Potential for liability.

For peer review to be effective, the schedule for the reviews must be estimated and included as part of the project schedule, and time must be allowed for the reviews. The selected peer review(s) should be notified of their expected participation as soon as possible.

A peer reviewer should be selected based on the following:

- The reviewer must be independent of the project. The reviewer must be sufficiently informed concerning the project, but should not be making the decisions which determine the course of the project. It is intended that peer review be an "outside" overview of the project.

- The reviewer must be a person knowledgeable in the area of work, preferably a senior technical person. Peer reviewers can be part of the IT organization, or outside consultants.

At the conclusion of a peer review, the reviewer(s) shall prepare a report to the Operations Manager, Project Manager, and Quality Assurance Officer. The report shall include the items listed in Section 9.3.

4.6 PROPOSAL PREPARATION

This discussion of proposal preparation is presented last because the other activities and processes discussed must either be in place or take place concurrently. The intent of this section is to provide a general overview of the proposal process. Detailed guidance for proposal preparation is given in the "Environmental Projects Group Policies and Procedures Manual."

4.6.1 Proposal Receipt and Viability Determination

Proposal activities are generally initiated by the receipt of a proposal solicitation. This may be referred to as an "invitation to bid," or "request for proposal (RFP)." The proposal solicitation generally contains information describing the work to be performed, the quantities of materials and services expected to be used, methods and basis of payments, proposal format, method of contractor selection, and terms and conditions of the awarded contract.

Upon receipt, the proposal solicitation will be marked with the time and date and routed to the Operations Manager for a project viability determination or the "Go/No-Go" Decision.

The preparation of a proposal requires a serious commitment of IT resources. For this reason, a determination must be made concerning the viability of the proposed project. Several factors are considered and each must be carefully weighed. Some of these factors are:

- Scope of work
- Site conditions
- Acceptability of work considering risk to IT
  - Risk during performance
  - Potential short- and long-term liability
- Compatibility with IT resources, i.e., does IT have the necessary personnel, equipment, and experience to perform the work without undue risk
- Client characteristics
- Will IT be adequately rewarded for assuming the risks of the project
- Expected competition
- Permitting, i.e., will IT be expected to acquire permits for the project

- Legal implications
- Insurance and bonding requirements
- Cost of proposal preparation.

During the viability determination, each of the above items must be addressed. The results of the viability determination should be documented by the use of the "Go/No Go" Decision form described in the "Policies and Procedures Manual."

4.6.2 Propsoal Team Selection

After the decision is made to respond to the proposal solicitation with a proposal, the proposal team is selected. A proposal manager is appointed to direct the preparation of the proposal. Other members of the proposal team are selected based upon their experience with the type of project being proposed or their experience in proposal preparation.

The proposal team members fall into one of two general categories: active team members and review members. The active team members actually perform the cost estimates, write the narrative sections of the proposals, and prepare the figures that may be included. Reviewers verify that the proposal is correct in both the technical and cost aspects. The reviewers are composed of those in legal/contractual, technical, and managerial positions.

Depending on the individual proposal circumstances, it may be necessary to perform a peer review of the technical and cost proposal. Peer review is discussed in Section 9.3 of this Manual.

4.6.3 Proposal Development

The first task in developing a proposal is acquiring data. Some projects may not require information beyond that given in the proposal solicitation package. Others may require visiting the site and meeting with

representatives of the prospective client as well as performing a literature/information survey. Site visits and meetings with prospective clients shall be documented by internal memoranda or meeting minutes and distributed to the proposal team members and the file. The literature/information survey will be conducted and documented in accordance with Section 5.1 of this Manual.

After the available information is gathered and disseminated, the technical approach to the prospective project is developed. The technical approach is developed and documented in accordance with the provisions of Section 6.0 - Modeling and Design and Section 9.0 - Report Preparation of this Manual and Section 6.0 - Bidding Decision and Proposal Preparation of the Policies and Procedures Manual.

The technical approach may require the development of all or some of the following:

- Preliminary design
- Work plan
- Sampling plan
- Quality Assurance Project Plan
- Health and Safety plan
- Scope of work
- Schedule.

The cost estimate is prepared after or concurrent with the technical approach.

The cost estimate is based on the technical approach. Whenever possible, the estimate shall be documented using standard IT calculation forms.

A substantial portion of a project may involve materials, equipment, and services provided by external suppliers or subcontractors (Section 4.4). Subcontractor pricing information must be documented. A written quotation from the potential supplier describing the material or services to be provided and the price is the preferred method of documentation. As a minimum, a

telephone confirmation memorandum may be written. It is recognized that, in some instances, due to scheduling or other factors, it is not possible to obtain external pricing for every item. The costs for these items must be estimated based on previous quotations for similar items, actual cost information from previous projects, nationally published cost data, or in the absence of the preceding, the estimator's experience. Reviewers must pay particular attention to these items.

Prior to issuance of the proposal, it shall be reviewed by knowledgeable members of the proposal team including the proposal manager and either the Operations Manager or other member(s) of Management depending on the cost or exposure level. The levels of review are presented in the "Policies and Procedures Manual." The review shall address whether:

- The proposal satisfies the scope of work, client requirements, and pertinent regulatory requirements.
- Assumptions and exceptions are clearly stated, justified, and documented.
- A reference is cited for information utilized in proposal preparation that was originated external to the project.
- Cost estimates are prepared, checked for both numerical accuracy and completeness, and approved according to IT requirements.
- The tables and figures presented in the proposal are prepared, checked, and approved according to IT requirements.
- The proposal has been proofread and punctuation, grammar, capitalization, and spelling are correct.

In addition to review by the proposal team, the proposal may undergo a peer review process. The peer review process is intended to complement the verification of numerical accuracy and proposal preparation. While verification

provides review and confirmation of largely definitive work, peer review provides evaluations and assessment of interpretations, judgments, and decisions.

Peer reviews shall be coordinated by the Operations Manager or proposal manager, as appropriate, responsible for the proposal. The review shall be performed in accordance with the procedures outlined in Section 9.3 of this Manual.

4.6.4 Verification of Cost Estimates

Accurate cost estimates are critical to the success of a project. While it is difficult to verify the estimated costs for the uncertainties surrounding a project, the numerical accuracy of the estimate can be verified. The cost estimate verification procedure follows the same procedure as the one used for checking calculations (Section 6.3).

In addition to checking the numerical accuracy of the estimate, the checker shall verify that prices submitted by subcontractors are properly documented by written quotes from the subcontractors and that transfers from individual estimate sheets to summary sheets are complete.

TABLE 4-1

QUALITY LEVEL I - TYPICAL QA/QC FUNCTIONS
("Standard" level of practice)

QC FUNCTIONS	QA FUNCTIONS
Evaluation of potential subcontractors (Section 4.4.2)	Quality Assurance/Quality Control training of Project personnel (Section 4.3)
Project Group review of procurement documents (Section 4.4.1.2)	Quality Assurance personnel review(s) of selected project activities, as necessary
Preparation of project-specific procedures (Section 3.2)	Formal Quality Assurance audits of laboratory operations (Section 11.1.2.1) and office operations (Section 11.1.2.2)
Use of documented and/or referenced procedures (Section 3.2)	Quality Assurance personnel review of procurement documents (Section 4.4.1.2)
Identification and calibration of field and laboratory equipment (Section 5.5)	
Environmental laboratory certification by external agencies (ITAD Quality Assurance Manual)	
Documentation of receipt of project materials from external sources (Section 10.3)	
Verification of subcontractor performance (e.g., quality checks and inspection) (Section 4.4.2)	
Identification and control of samples (Section 5.3)	

TABLE 4-1
(Continued)

QC FUNCTIONS	QA FUNCTIONS
Laboratory Quality Control testing and evaluation (e.g.; blanks, duplicates, spikes, and standards) (ITAD Quality Assurance Manual)	
Documentation of project activities (e.g.; field activity logs, photographs, sample collection forms, equipment calibration records, chain of custody forms, test data forms, analysis and design calculations, computer program verification, logs, drawings, and tables) (Sections 5.2.2 and 6.2 and throughout this Manual)	
Checking of final data reduction, calculations, computer input, logs, drawings, and tables (Sections 5.2.3, 5.4.3, and 6.3)	
Verification of computer programs (Section 6.3.2)	
Documentation of nonconformances and changes to project scope of work, specifications, and technical contractual requirements (Sections 5.2.2, 7.0, and 8.0)	
Indication of document status (e.g., preliminary or void) (Sections 6.2 and 10.0)	
Control and retention of project records (Section 10.0)	

TABLE 4-2

QUALITY LEVEL II - TYPICAL QA/QC FUNCTIONS
(Full Quality Assurance Application)

QC FUNCTIONS	QA FUNCTIONS
All those functions listed for Level I (Table 4-1)	Quality Assurance/Quality Control training of project personnel (Section 4.3)
Formal delegation or "pass down" of quality requirements to subcontractors (Section 4.4)	Quality Assurance personnel review of procurement documents
Interlaboratory testing program	Certification of auditors (nuclear projects only) (Section 4.3.3)
Evaluation of recurring nonconformances (Section 8.0)	As appropriate, formal Quality Assurance audits of: - potential subcontractors (prequalification) (Sections 4.4.2 and 11.1.1.4) - subcontractor performance (Sections 4.4.2 and 11.1.1.5) - field activities (Section 11.1.1.1) - laboratory operations (Section 11.1.2.1) - final reports and data transmittals (Section 11.1.1.2) - project files (Section 11.1.1.3)
"Lifetime" record storage (i.e., for life of project facility) (Section 10.5)	

TABLE 4-3

ELEMENTS WHICH INFLUENCE DEGREE OF TECHNOLOGY

- Availability of technical information applicable to the project
- Number of simplifying assumptions which must be made
- Mandated site related requirements (i.e., information necessary to determine the suitability of a site)
- Equipment and instrumentation requirements
- Methods to be used for:
  - Site exploration
  - Sampling
  - Field monitoring
  - Field and laboratory testing
  - Data processing
  - Design computation methods
- Design criteria
- Required accuracy and precision of final technical results
- Performance objectives
- Operational requirements
- Methods required for implementation of recommendations

TABLE 4-4

DEGREE OF COMPLEXITY

QUESTION	ANSWER	DEGREE OF COMPLEXITY
How many persons will be involved?	Few Many	Low High
How many organizations and/or offices will be involved?	Few Many	Low High
What level of logistic complexity (e.g.; number and locations of sites, suppliers, sampling stations, monitoring stations, and test facilities) will be necessary?	Low High	Low High
What is the potential for IT liability exposure?	Low High	Low High
What is the potential for IT industry or public exposure?	Low High	Low High
What is the potential for adversely affecting the health and safety of the public and/or IT employees?	Low High	Low High
What is the potential for adversely affecting the environment?	Low High	Low High
How many "problems" are anticipated?	Few Many	Low High
What is the potential for detailed review by the client and/or a government agency?	Low High	Low High
What is the potential for major changes in the scope of work?	Low High	Low High
How difficult will it be for management to monitor the entire project?	Easy Hard	Low High
What is the magnitude of the ratio of volume of work to be generated to the time duration of the project?	Low High	Low High

TABLE 4-4
(Continued)

QUESTION	ANSWER	DEGREE OF COMPLEXITY
How complex are mandated siting requirements (i.e., information necessary to determine the suitability of a site)?	Simple Detailed	Low High
What is the estimated variability in critical site characteristics (e.g.; geologic, hydrogeologic, geotechnical, geochemical, hydrologic, meteorologic, and socioeconomic)?	Slight Complex	Low High
What is the estimated variability in hazardous material characteristics (e.g., type, amount, composition, extent, and compatibility)?	Slight Complex	Low High
How complex are design criteria parameters and/or performance objectives?	Simple Detailed	Simple High
What are the necessary accuracy and precision of final technical results?	Simple Detailed	Low High
How complex are recommended construction and/or operation requirements?	Simple Detailed	Low High
Are additional documentation requirements complex and exacting?	Simple Detailed	Low High

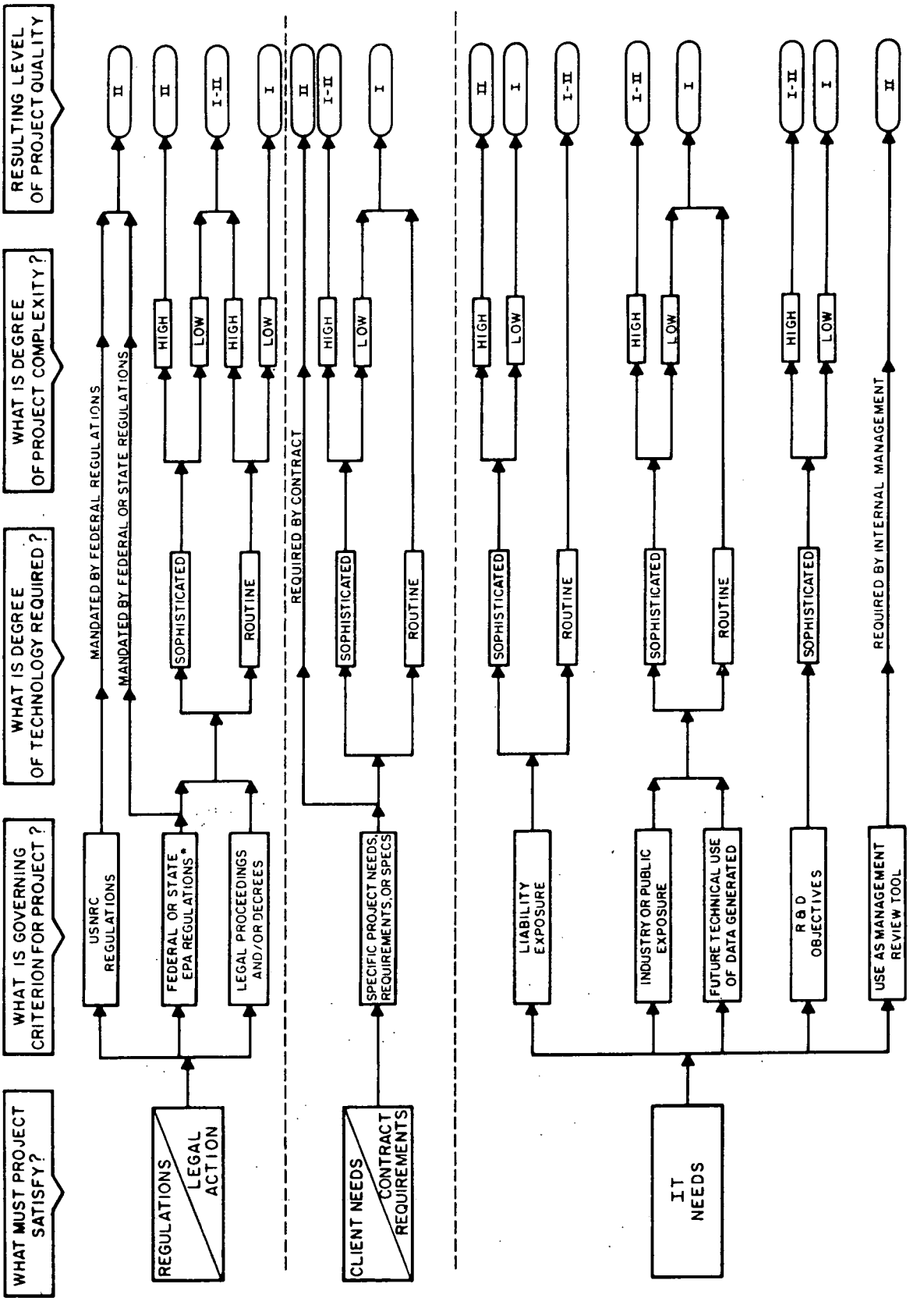


FIGURE 4-1
DECISION TREE FOR DETERMINING PROJECT QUALITY LEVEL

NOTE:
*INCLUDES EPA "INTERIM GUIDELINES AND SPECIFICATIONS FOR PREPARING QUALITY ASSURANCE PROJECT PLANS QAMS-005/80 AND EPA "TECHNICAL GUIDANCE DOCUMENT: CONSTRUCTION QUALITY ASSURANCE FOR HAZARDOUS WASTE LAND DISPOSAL FACILITIES EPA/530-SW-86-031

5.0 DATA ACQUISITION

Data is generally acquired by literature/information surveys, field investigation and sampling, and/or laboratory analysis. Quality-related activities associated with each method shall be performed in accordance with approved written procedures, using calibrated equipment as necessary. Samples obtained shall be properly identified and controlled to retain in situ characteristics. All daily activities, data, data reduction, results, and variances to procedures shall be documented. Data reduction shall be checked using the standard IT process (Section 6.3.1).

5.1 LITERATURE/INFORMATION SURVEY

During project planning, the need to assemble pertinent information previously developed by IT or others shall be determined. The intensity of the survey shall be determined by the Project Manager dependent on the needs of the project. Acquired information may include:

- Applicable federal, state, and local regulations and rulings
- Project status
  - History/background
  - Future plans
  - Client requirements/schedule
- Methodologies available for:
  - Field exploration, testing, and sampling
  - Laboratory testing
  - Processing and volume reduction of hazardous material
  - Isolation and disposal of hazardous material
  - Numerical analysis and design
- Existing data generated for a specific region or site
  - Geological (surface and subsurface)

- Ground water (configuration and usage)
- Hydrological/meteorological
- Geochemical
- Geotechnical
- Seismological
- Population distribution
- Industrial development and practices (past, present, and future)
- Type, volume, and extent of contamination
- Physical layout of man-made facilities

• Data generated on specific materials or chemical compounds of interest
  - Physical
  - Chemical
  - Geochemical
  - Mechanical
  - Thermomechanical
  - Toxicity/hazards and protection

• Quality of existing data. (Is the data adequate for the needs of the project?)

• Previous or concurrent, surveys, studies, analyses, and designs of a similar or parallel nature.

Sources for the above information may include:

• Government and private regulations, standards, guidelines, journals, periodicals, and data compilations

• Textbooks and maps

• Reports and manuals previously issued by IT, the client, or other organizations

• Results of presently ongoing investigations by government and private agencies, corporations, and research facilities

- Personal communications
- Aerial photographs and satellite imagery
- Procurement documents issued by the client.

Information collected shall be documented to indicate its source. Documentation shall, as appropriate, include author or individual contacted; title; identification of periodical or journal; standard, guideline, or report number; identification of publisher or originating organization; page location; and date. Documentation must be sufficient to allow other individuals to easily obtain or verify the information.

Whenever possible, complete copies of articles, data compilations, maps, reports, and photographs shall be included in the project files. If this is not feasible, copies of title pages and pertinent sections shall be included with complete source documentation. Regulations, standards, guidelines, and textbooks, which are generally not project specific, may be obtained and kept in the office library if they are of a unique nature or will be used on several projects.

Personal communications such as interviews, correspondence, or telephone conversations shall be completely documented in the form of trip reports, meeting notes, memorandums, and telephone records and the resulting documentation included in the project files. Provide, as appropriate, the name, organization, date, address, phone number, and credentials of all individuals contacted. A request shall be made for formal written confirmation of critical data obtained by telephone to serve as final documentation.

5.2 FIELD INVESTIGATION AND SAMPLING

This section discusses the performance and documentation of quality-related field activities. These activities can include site reconnaissance, surface and subsurface exploration, field surveys and testing, and collection of samples for subsequent laboratory analyses.

5.2.1 Performance

Field investigation and sampling shall be performed in accordance with documented and approved procedures, such as Manuals of Practice and project-specific plans (Sections 3.2 and 3.3 discuss preparation, review, and approval of procedures). Procedures shall provide for performance of activities under suitably controlled conditions which include the use of appropriate materials and calibrated equipment, environmental conditions, and completion of any prerequisites.

When appropriate, generic procedures shall be supplemented by project-specific work or sampling plans. Generic procedures shall be written with sufficient detail to provide guidance to the Project Team. Generic procedures may be prepared on the region, office, and group level. The plans may identify specific project tasks, required equipment and materials, approved procedures for work performance, prerequisites to be completed prior to performance, and activity schedule. Plans shall be sufficiently flexible to permit field necessitated changes while maintaining desired control. Original plans, and any revisions to them, shall be reviewed and approved by Project Group and Quality Assurance personnel as stated in Section 3.3.1. Work and sampling plans will be developed prior to commencing work or sampling activities.

Field activities are the responsibility of the Project Manager and Field Supervisor. Prior to initiating field work, the Project Manager shall discuss the scope of work, contractual and regulatory requirements, and applicable Quality Assurance/Quality Control procedures with assigned personnel. At the request of the Project Manager, this may be done by Quality Assurance personnel or senior members of the Project Staff. This discussion shall be documented by a memorandum to the file listing the attendees and the topics discussed.

Once in the field, IT field personnel are responsible for all daily Quality Control activities. Included in this responsibility shall be the supervision of IT subcontractors.

can provide adequate documentation of work activities should the originals be destroyed, lost, or stolen.

5.2.3 Variances

Variances from standard approved field operational procedures and plans shall be documented in a Variance Log (Figure 5-2) or equivalent form. It is recognized that procedures such as work plans cannot be prepared which properly foresee all conditions encountered during a field program. The Field Supervisor shall initiate and chronologically maintain the Variance Log. All items recorded in the Variance Log require the approval of the Project Manager and the appropriate Quality Assurance Officer. Approval by the Project Manager can be initiated on a verbal basis via telephone. It is suggested, as normal practice, that the Field Supervisor communicate via telephone with the Project Manager at least weekly. The Variance Log shall contain: date and nature of the variance, applicable document, and IT personnel initiating the variance. In no case shall a subcontractor initiate a variance. If a variance is proposed by the client, it shall be so recorded.

Formal approval of the Variance Log shall be in writing. The Project Manager shall be provided with a copy of all entries made in the log. Upon receipt the Project Manager shall review copies of the logs and, when in agreement, indicate approval by signing and dating each variance. The copy shall be forwarded to the Quality Assurance Officer for review, signing, and dating and then returned to the Project Manager for inclusion in the project files. Originals of the Variance Log shall be kept on site until the field work is complete.

Variances to approved procedures and plans will be approved prior to implementing the deviating action.

Copies of the daily activity logs should be sent to the Project Manager, or a senior member of the Project Staff, approximately on a weekly basis. After review of the logs, they should be routed to other members of the Project Staff as needed. If the logs are not submitted as required, it is the responsibility of the Project Manager, or designee, to contact the field personnel.

As part of field activities, a photographic record should be prepared. Photographs should be in color. As examples, photographs should be taken of the general site layout, geologic features, field equipment and installations, sampling stations, and field testing. When test pits or trenches are dug, photographs should be taken of the subsurface profiles if possible.

Photographs are to be identified with the project number, date taken, and a brief description. This may be done individually on the back of the photographs or in an album in which the photographs are mounted. Album photographs must be provided with individual descriptions and dates taken.

Before photographs are taken, the client should be contacted to determine their policy concerning photographs.

Appropriate test survey and equipment installation data forms shall also be prepared. They shall include, as appropriate, the activity location (e.g., boring, test pit, depth, sampling station, elevation, and field coordinates) and the items listed in Section 5.4.2 for laboratory test data forms. All requested information shall be addressed. If not applicable, requested information should be designated as such by entering "NA."

All field records shall be collected and maintained by the Field Supervisor until completion of the field program or program phase, or until they are submitted to the project central file (Section 10.2.1). During the performance of a field program, it is recommended that a copy of the field records be periodically made and sent to the Project Manager. These copies

Generic methods for field investigation and sampling are presented in IT Manuals of Technical Practice associated with this Quality Assurance Manual and in various internal technical procedures.

5.2.2 Performance Documentation

To provide evidence of satisfactory work performance and the basis for subsequent activities and information transmitted external to IT; data, data reduction, and results of field investigations and sampling shall be completely documented. Whenever possible, information shall be recorded on a standardized form or alternately in a bound field logbook. If a bound logbook is used, the logbook will be dedicated to a specific project and will be stored in the project file. It is recommended that bound logbooks be used only when required by regulations or client requests. Documentation shall include a daily log of project activities and the appropriate subsurface logs, test and survey data forms, monitoring/sampling equipment installation records, photographs, and field collection and sampling custody forms.

Members of the Project Staff working in field operations shall keep a daily log of project activities. Standard IT forms such as is shown in Figure 5-1 should be used. Each page of logbooks or daily activity logs shall be signed and dated by the person preparing the log. Items to be included in the daily log, as appropriate, are:

- Date of activities
- Project identification
- Field activity subject
- General work activity
- Unusual events
- Changes to plans and specifications
- Visitors on site
- Subcontractor progress or problems
- Communication with the client or others
- Weather conditions
- IT personnel on site
- Consecutive page numbers.

5.2.4 Verification of Data Reduction

The numerical reduction of field data shall be formally checked using the standard IT process outlined in Section 6.3.1. Checking shall be performed prior to the presentation of results. If it becomes necessary to present or use unchecked results, transmittals or subsequent calculations shall be marked "preliminary" until such time that the results are checked and determined to be correct.

All data reduction and resulting tables and graphs shall be checked. This includes computer input (see Sections 6.2.2 and 6.3.2), if reduction is performed by computer. Data sheets shall be complete, with all requested information addressed.

The verification of field data reduction is the responsibility of Project personnel. The assignment of a checker shall be made or approved by the Field Supervisor or the Project Manager.

5.3 SAMPLE CONTROL

Field personnel are responsible for the identification, preservation, packaging, handling, shipping, and storage of samples obtained in the field so that all samples can be readily identified and that they will retain, to the extent possible, in situ characteristics to be determined through testing. Specific information on sample control is presented in the ITAS Quality Assurance Manual, IT Manuals of Practice, and various internal technical procedures.

All samples collected by IT personnel must be validated through the preparation of a chain-of-custody form.

5.3.1 Samples for Chemical Analysis

This section discusses the control of samples taken for chemical analysis. The media to be sampled can be water, air, soil, sludge, etc.

5.3.1.1 Identification

Samples shall be adequately marked for identification at the time of collection. Marking shall be on a tag or label attached to the sample container (jar, bottle, bag, etc.). Sample identification shall include, as a minimum:

- Project name and number
- Unique sample number
- Sampling location (e.g., boring, depth or sampling interval, and field coordinates)
- Sampling date and time
- Individual performing the sampling
- Preservation or conditioning employed.

An example identification label for chemical analysis samples is shown in Figure 5-3.

5.3.1.2 Chain of Custody

An overriding consideration for data resulting from chemical analyses is the ability to demonstrate that the samples were obtained from the locations stated and that they reached the laboratory without alteration. Evidence of collection, shipment, laboratory receipt, and laboratory custody until disposal must be documented to accomplish this. Documentation shall be accomplished through a chain-of-custody form that records each sample and the individuals responsible for sample collection, shipment, and receipt. A sample is considered in custody if it is:

- In a person's actual possession
- In view, after being in physical possession
- Locked so that no one can tamper with it, after having been in physical custody
- In a secured area, restricted to authorized personnel.

Figure 5-4 shows an example chain-of-custody form to be used by IT personnel in collecting and shipping samples. An ITAS laboratory will not accept samples collected by IT personnel for analysis without a correctly prepared chain-of-custody form.

The IT chain-of-custody form is a two-part form consisting of a white original and a yellow field copy. They are preprinted with a unique six-digit chain-of-custody control number in the upper right-hand corner. The white copy always accompanies the sample while the yellow field copy is retained in the field project file. The contents of this file are eventually transferred to the project central file at the completion of the field program or at intervals designated by the Project Manager.

The chain-of-custody form shall be signed by each individual who has the samples in their possession. Preparation of the chain-of-custody shall be as follows:

- The chain-of-custody record shall be initiated in the field by the person collecting the sample, for every sample. Every sample shall be assigned a unique identification number that is entered on the chain-of-custody form. Samples can be grouped for shipment and use a common form.

- If the person collecting the samples does not transport the samples to the laboratory or deliver the sample containers for shipment, the first Relinquished By _____, Received By ___ shall be completed in the field. It is noted that the names of all members of the sampling team shall be listed on the chain of custody.

- The person transporting the samples to the laboratory or delivering them for shipment shall sign the record form as Relinquished By _____.

- If the samples are shipped to the laboratory by commercial carrier, the original chain-of-custody form shall be sealed in a watertight container, placed in the

shipping container, and the shipping container sealed prior to giving it to the carrier.

- If the samples are directly transported to the laboratory, the original chain-of-custody form shall be kept in possession of the person delivering the samples.

- For samples shipped by commercial carrier, the waybill shall serve as an extension of the chain-of-custody record between the final field custodian and receipt in the laboratory. (The carrier and waybill number will be written on the chain-of-custody form. If the original chain-of-custody form is sealed in the shipping container before the waybill number is received, then this number will be written on the copy of the chain-of-custody form.)

- Upon receipt in the laboratory, the Quality Control Coordinator, or representative, shall open the shipping containers, compare the contents with the chain-of-custody record, and sign and date the record. The Quality Control Coordinator will also record the carrier and waybill number on the original chain-of-custody form, if it is not already present. The Quality Control Coordinator will check the temperature, if appropriate, inside the shipping container and record the temperature on the chain-of-custody form. Any discrepancies shall be noted on the chain-of-custody form.

- If discrepancies occur, the samples in question shall be segregated from normal sample storage and the field personnel immediately notified.

- The chain-of-custody form is completed after sample disposal. Note the blanks for this purpose in Figure 5-4.

- Chain-of-custody records shall be maintained with the records for a specific project, becoming part of the data package.

- The following documentation may supplement the chain-of-custody records:

  - Field notebook prepared by a member of the sample team. The field notebook shall provide supporting information regarding sample collection.

- Sample label on each sample
- Sample collection log (Figure 5-5) and request for analysis forms (copies accompany the samples) Figure 5-6.
- Photographic records (wherever practical).

5.3.1.3 Preparation, Packaging, Handling, and Shipping

Samples shall be placed in containers compatible with the intended analysis and properly preserved. Also, control of samples must consider the time interval between acquiring the sample and analysis (holding time) so that the sample is representative. Table 5-1 has been provided to denote requirements for various analytical parameters with respect to the type of container, preservation method, and maximum holding time between collection and analysis. Polyethylene or glass containers are required; and, in most cases, samples must be cooled to four degrees Centigrade (4°C) The table also provides the recommended sample volume for a specific analysis. This table is from the ITAS Quality Assurance Manual. Other packaging and shipping requirements are outlined in the "Manual of Practice: Sample Packaging and Shipment."

Samples to be shipped off site for chemical analysis shall be placed in ice chests containing "blue ice" or a similar pack of frozen gel and packed to prevent breakage during shipment. The ice chest shall be sealed, addressed, identified, and placarded as appropriate. Dry ice and water ice are not acceptable coolants.

As soon as field personnel have consigned samples to a commercial carrier, they shall notify the laboratory by telephone of the shipment. If the samples are transported by field personnel, the estimated time of arrival at the laboratory should be given.

The final step in providing information to the laboratory is shown in Figure 5-6. The Request for Analysis form shall be completed by the field personnel, or other Project personnel if appropriate, and included with the chain-of-custody record. It is imperative that the Request for Analysis be provided so that analytical requirements are defined and sample holding times are not exceeded.

The IT Request for Analysis form is a two-part form similar to the IT chain-of-custody form. The white original accompanies the sample, while the yellow copy is retained in the field file.

Transportation shall enable samples to arrive at the laboratory in time to permit testing in accordance with established sample holding time and project schedule. No samples shall be accepted by the receiving laboratory personnel unless they are properly labeled and sealed.

5.3.1.4 Storage

Sample storage in the field and laboratory shall generally be in a refrigerated (four degrees Centigrade), secure area until required analyses are completed. Field and laboratory storage are the responsibility of the Field Supervisor and Laboratory Manager, respectively. In general, samples shall not be kept longer than six months beyond the completion of analysis, unless otherwise specified.

5.3.2 Samples for Geotechnical Analysis

Following is a discussion of the control of samples (soil or rock) obtained for geotechnical analyses.

5.3.2.1 Identification

Geotechnical samples shall be adequately marked for identification from the time of collection and packaging through shipping and storage. Marking shall

generally be on the sample container (corebox, undisturbed tube, jar, bag, etc.); but may be applied directly to the sample, or on a tag or label attached to the sample or container, depending on the type of sample and its intended use. Sample identification shall include, as appropriate:

- Project name and number
- Unique sample number
- Sampling location (e.g., boring, test pit, depth or sampling interval, and field coordinates)
- Sampling date.

Additional information may be included in response to internal technical procedures or at the discretion of the Field Supervisor.

5.3.2.2 Packaging, Handling, and Shipping

Packaging of geotechnical samples shall be based on the protection a sample requires during handling, shipping, and storage. The size and material of containers, methods of container closing or sealing, and packaging of containers for shipment shall maintain desired in situ characteristics to the extent possible. Table 5-2 has been provided to denote the requirements for shipping and preservation of samples for various geotechnical tests.

Samples shall be handled and shipped so that damage, loss, or unacceptable deterioration is prevented. Suitable handling precautions, environmental protection, and methods of transportation shall be employed. Transportation shall be provided so that samples arrive at the laboratory in time to permit testing in accordance with project schedule. Special emphasis shall be placed on the handling and shipping of undisturbed geotechnical samples. Whenever possible, these samples should be transported by IT personnel. Undisturbed geotechnical samples shipped as freight shall be packed to prevent movement in the package and to reduce shock, vibration, and disturbance. Specific requirements for handling and storage of undisturbed samples may be developed for individual projects.

Samples shipped, or hand carried, to an IT laboratory shall be accompanied by a Request-for-Analysis form (Figure 5-6).

5.3.2.3 Storage

Field storage of samples shall be adequate to prevent damage, loss, or unacceptable deterioration. Samples shall not be subjected to excessive moisture or large temperature variations. They shall not be allowed to freeze, if the in situ characteristics to be determined by testing could be affected. Indoor storage shall be employed, where possible, to provide a controlled environment. All field storage shall be under the direction of the Field Supervisor.

Laboratory storage of samples prior to testing shall follow the above requirements. Storage supervision is the responsibility of the Laboratory Manager. For the storage of samples which remain after testing, IT also maintains storage facilities. Samples from nuclear-related projects stored in these facilities shall be recorded on an inventory sheet with copies on file in the laboratory and the storage facility, if separate from the laboratory. An example of an inventory sheet for geotechnical samples is presented in Figure 5-7. Samples shall be stored by type and project number. The type of sample, sample number, sampling location, date stored, and date for sample disposal shall be indicated.

Depending upon regulatory and client requirements, samples remaining after testing is complete may be disposed of at the option of the Project Manager. In general, samples shall not be kept longer than six months. As appropriate, transferal to the client or owner may be arranged.

5.3.2.4 Chain of Custody for Geotechnical Samples

The chain-of-custody procedure (Section 5.3.1.2) will be used for all geotechnical samples. The following reasons for using a chain of custody for chemical samples are also often appropriate for geotechnical samples:

- Demonstrating origin of the samples
- Demonstrating the samples have not been altered (or alteration minimized) from the time of collection to testing.

Examples of the chain-of-custody procedure being utilized for geotechnical samples could be:

- Obtaining undisturbed samples from a clay liner to demonstrate that strength characteristics and permeability meet specification requirements
- Collecting samples from potential borrow areas for laboratory analyses to determine appropriate compaction requirements to meet project objectives
- Demonstrating in situ strength and permeability of soils which will not be subject to site remediation.

5.4. LABORATORY ANALYSIS

This section discusses the general performance and documentation of laboratory chemical and geotechnical analyses. Detailed guidance for these activities is presented in the appropriate laboratory Quality Assurance Manuals.

5.4.1 Performance

Quality-related laboratory operations shall be documented in approved procedures (as discussed in Section 3.0). Procedures shall provide for accomplishment of activities under suitably controlled conditions which include the use of appropriate materials and calibrated equipment, suitable environmental conditions, completion of prerequisites, and the analysis of Quality Control samples.

When appropriate, individual procedures shall be supplemented by project-specific project work and test plans. The plans may identify specific project tasks, required equipment and materials, approved procedures for work performance, prerequisites to be completed prior to performance, and activity

schedule. The plans shall be sufficiently flexible to permit change while maintaining desired control. The original plans, and any revisions to them, shall be reviewed by the Project Group and Quality Assurance personnel. Approval shall be provided by project management.

A laboratory testing program is the joint responsibility of the Project Manager and appropriate Laboratory Manager(s). Project personnel shall provide the Laboratory Staff with information necessary to perform the testing program, while the Laboratory Staff shall conduct the testing in accordance with approved procedures. Figure 5-8 shows the progress of testing program activities.

The scheduling and execution of a testing program is the responsibility of the appropriate Laboratory Manager; however, the manager should be notified by field personnel as to when samples will arrive for testing. As part of the testing program, the Laboratory Manager is responsible for the completion, checking, and organization of all laboratory data sheets and calculations and the release of testing results to Project personnel.

5.4.2 Performance Documentation

To provide evidence of satisfactory work performance and the basis for subsequent activities and information transmitted external to IT; the test program initiation, data, data reduction, and results of laboratory testing shall be completely documented. Whenever possible, information shall be recorded on a standardized form or a bound laboratory logbook.

To initiate a testing program, a Laboratory Testing Record and/or Work Assignment Sheet shall be prepared by project personnel and appropriate laboratory management. An example of a geotechnical Laboratory Testing Record is provided in Figure 5-9 at the end of this section. For tests that require unique, test-specific input parameters, a Testing Procedure Record (Figure 5-10) shall be completed.

Test data forms shall be completed during testing and the subsequent data reduction. All requested information shall be addressed. This information shall include, as appropriate:

- Project name and number
- Identification of test personnel
- Testing date
- Identification of calibrated equipment used (Test Equipment List giving equipment name and unique identification number)
- Identification and description of sample(s) tested
- Test data and any subsequent data reduction
- Test results in the form of tables and curves
- Unusual conditions encountered.

If not applicable, requested information should be designated as such.

For chemical analysis the collection and evaluation of Quality Control data (e.g., standard evaluations and duplicate and matrix spike testing) shall be completely documented on test data forms and the results presented in the form of Quality Control charts for precision and accuracy.

All laboratory administrative forms, test data, computer printout, and checkprints shall be organized and maintained by the Laboratory Managers in accordance with the requirements of Section 10.0.

Variances from standard approved laboratory operational procedures and plans shall be documented in a Testing Procedure Record (Figure 5-10), or equivalent form. This record is to be completed by appropriate laboratory management and maintained with the associated testing records.

5.4.3 Verification of Data

5.4.3.1 Analysis of Quality Control Samples

For chemical analysis, Quality Control samples shall be used to demonstrate that a laboratory is operating within prescribed requirements for precision and accuracy (Section 8.0 of the ITAS Quality Assurance Manual). Typical Quality Control samples include:

- Reagent and method blanks
- Field blanks
- Check standards
- Surrogate and internal standards
- Duplicate samples
- Matrix spike samples
- Standard reference materials.

Quality Control samples shall be processed and the results statistically evaluated to assess the validity of each data set. Precision and accuracy Quality Control charts (Figure 5-11) shall then be developed and updated for each analytical parameter (Section 10.0 of the ITAS Quality Assurance Manual).

5.4.3.2 Verification of Data Reduction

The numerical reduction of laboratory data shall be verified using the standard processes outlined in Section 10.0 of the ITAS Quality Assurance Manual for chemical analysis, and Section 6.3.1 of this Manual for geotechnical testing. Checking shall be performed prior to the presentation of results. If is becomes necessary to present or use unchecked results, transmittals or subsequent calculations shall be marked "preliminary" until such time that the results are checked and determined to be correct.

Data reduction (generally 20 percent of all data for chemical analysis and 100 percent for geotechnical analysis) and any resulting summaries, tables, and graphs shall be checked. This includes computer input (Sections 6.2.2 and 6.3.2) if reduction is performed by computer. Data sheets shall be complete, with all requested information addressed.

The verification of laboratory data reduction is the responsibility of laboratory personnel. The assignment or approval of checkers is the responsibility of the appropriate Laboratory Manager.

5.5 EQUIPMENT CALIBRATION AND CONTROL

Measuring and test equipment used in the field or IT laboratories and IT reference equipment shall be controlled and subject to a formal calibration program. Documentation of control of the equipment shall be by sign-out/sign-in procedures. Equipment shall be stored in secure areas. Other IT policies provide details and guidance for equipment control. The calibration program shall provide equipment of the proper type, range, accuracy, and precision to supply data compatible with project requirements and desired results. Calibration of measuring and test equipment may be performed internally using IT reference equipment and standards, or externally by agencies or manufacturers. Calibration of in-house reference equipment is, in general, performed externally.

The responsibility for the calibration of IT laboratory and associated reference equipment rests with the Laboratory Managers. Calibration of other equipment within the IT calibration system (Section 5.5.7) is the responsibility of the office or group maintaining that equipment. The Project Manager and Field Supervisor are responsible for the calibration of project-specific IT field equipment, which is not part of the calibration system, and field equipment provided by subcontractors.

5.5.1 Calibration Procedures

Documented approved procedures shall be used for calibrating measuring and test equipment and reference equipment. Whenever possible widely accepted procedures, such as those published by ASTM or EPA, or procedures provided by manufacturers shall be adopted. Where preestablished information is not available, procedures shall be developed (Section 3.2) considering the type of equipment, stability characteristics of the equipment, required accuracy and

precision, and the effect of error on the quantities measured. As a minimum procedures shall include:

- Type of equipment to be calibrated
- Reference equipment and standards to be used
- Calibration method and sequential actions
- Acceptance tolerances
- Frequency of calibration
- Data recording form/format.

Calibration procedures for test equipment routinely calibrated by IT are presented in the ITAS Quality Assurance Manual and IT Manuals of Technical Practice.

5.5.2 Equipment Identification

Calibrated equipment shall be uniquely identified by using either the manufacturer's serial number, an IT calibration system (Section 5.5.7) identification number, or other means. This identification, along with a label indicating when the next calibration is due (only for equipment requiring periodic calibration), shall be attached to the equipment. If this is not possible, records traceable to the equipment shall be readily available for reference.

It is the responsibility of all personnel to verify calibration status from the due date labels or records prior to using the equipment.

5.5.3 Calibration Frequency

Measuring and test equipment and reference equipment shall be calibrated at prescribed intervals and/or as part of operational use. Frequency shall be based on the type of equipment, inherent stability, manufacturer's recommendations, values given in national standards, intended use, effect of error on the measurement process, and experience. Specific calibration frequencies are given in the ITAS Quality Assurance Manual and IT Manuals of Practice.

In some cases, particularly for field equipment, scheduled periodic calibration will not be performed because the equipment is not continuously in use. Such equipment shall be calibrated on an "as needed" basis prior to use, and then at the required frequencies for as long as its use continues.

5.5.4 Calibration Reference Equipment and Standards

Equipment shall be calibrated, whenever possible, using reference equipment and standards having known relationships to nationally recognized standards (e.g., National Bureau of Standards) or accepted values of natural physical constants. If national standards do not exist, the basis for the reference standard or calibration shall be documented.

Reference equipment shall be used only for calibration and shall be stored separately from working measuring and test equipment to prevent inadvertent use. In general, reference equipment shall be at least four to ten times as accurate as the equipment being calibrated.

5.5.5 Calibration Failure

Equipment that fails calibration or becomes inoperable during use shall be removed from service and segregated to prevent inadvertent use, or shall be tagged to indicate it is out of calibration. Such equipment shall be repaired and satisfactorily recalibrated to the satisfaction of the Laboratory Managers or Field Supervisors, as appropriate. Equipment that cannot be repaired shall be replaced.

Results of activities performed using equipment that has failed recalibration shall be evaluated by the involved Quality Assurance personnel and the Laboratory Manager or Project Manager, as appropriate. If the activity results are adversely affected, the results of the evaluation shall be documented and appropriate personnel notified.

Scheduled calibration of measuring and test equipment does not relieve any personnel of the responsibility of using properly functioning equipment. If an equipment malfunction is suspected, the device shall be tagged or removed from service and recalibrated. If it fails recalibration, the above process shall apply.

5.5.6 Calibration Records

Records shall be prepared and maintained for each piece of calibrated measuring and test equipment and each piece of reference equipment to indicate that established calibration procedures have been followed. Records for equipment used only for a specific project shall be kept in the project files. Records for equipment controlled by the IT calibration system (Section 5.5.7) shall generally be maintained by the Laboratory Managers (along with documentation demonstrating the accuracy of reference standards) or the offices or groups responsible for maintaining that equipment.

Records for periodically calibrated equipment shall include, as appropriate:

- Type and identification number of equipment
- Calibration frequency and acceptance tolerances
- Calibration dates
- Identities of individuals and organizations performing the calibrations
- Reference equipment and standards used for each calibration
- Calibration data
- Certificates or statements of calibration provided by manufacturers and external agencies, and traceable to national standards
- Statements concerning calibration acceptance or failure and repair of failed equipment.

Much of the measuring and test equipment used for field geophysical surveys or in the analytical laboratories is calibrated or checked as part of the operational use. For this equipment, records of the calibrations or checks shall be kept in the files of projects for which the work was performed, or as part of the responsible group calibration record system.

5.5.7 IT Calibration System

To provide control of measuring and test equipment and reference equipment routinely used by IT, a formal calibration system is employed. Each piece of equipment within the system shall be assigned a unique equipment number and tagged with that number so that calibration information pertinent to the equipment can be retrieved upon request. The equipment shall have an individual calibration file and be calibrated prior to use or as part of operational use.

In addition to the numbering and tagging of equipment, a recalibration date label shall, whenever possible, be applied to each item requiring periodic calibration. For convenience, the date labels may be made from plastic tape used in an embossing label maker.

Calibration files for the equipment controlled by the various laboratories, offices, and groups shall be maintained by the appropriate Laboratory Mangers, offices, or groups., Calibration files shall contain an Equipment Calibration Record form (Figure 5-12), IT calibration data forms and/or certificates of calibrations provided by manufacturers and external agencies, and any Notice of Equipment Calibration Failure (Figure 5-13).

For the transfer of equipment between laboratories and offices, the calibration files should be sent with the equipment so that a continuous updated record can be maintained. In general, recalibration of sensitive equipment should be performed following the transfer.

Equipment which fails calibration must be repaired to the satisfaction of the appropriate Laboratory Manager or Field Supervisor before it is reused, or it shall be removed from service. A Notice of Equipment Calibration Failure form (Figure 5-13) shall be completed and kept in the equipment file for items that are removed from service for failure to satisfy calibration requirements. Failure to pass calibration shall also be noted in the Equipment Calibration Record.

TABLE 5-1

SAMPLING AND PRESERVATION REQUIREMENTS

PARAMETER	CONTAINER[a]	VOLUME REQUIRED (mL)	PRESERVATION[b]	MAXIMUM HOLDING TIMES[c]
Bacterial Tests				
o Coliform, fecal and total	P,G	200	Cool 4°C, 0.008% $Na_2S_2O_3$[d]	6 hours
o Fecal streptococci	P,G	200	Cool 4°C, 0.008% $Na_2S_2O_3$[d]	6 hours
Inorganic Tests				
o Acidity	P,G	50	Cool 4°C	14 days
o Alkalinity	P,G	50	Cool 4°C	14 days
o Ammonia	P,G	100	Cool 4°C, H_2SO_4 to pH <2	28 days
o Biochemical Oxygen Demand	P,G	1,000	Cool 4°C	48 hours
o Biochemical Oxygen Demand (carbonaceous)	P,G	1,000	Cool 4°C	48 hours
o Bromide	P,G	200	None required	28 days
o Chemical Oxygen Demand	P,G	75	Cool 4°C, H_2SO_4 to pH <2	28 days
o Chloride	P,G	50	None required	28 days
o Chlorine, Total Residual	P,G	200	None required	Analyze immediately
o Color	P,G	50	Cool 4°C	48 hours
o Cyanide, Total and Amenable to Chlorination	P,G	1,500	Cool 4°C, NaOH to pH >12, 0.6g ascorbic acid[d]	14 days[e]
o Fluoride	P	300	None required	28 days
o Hardness	P,G	100	HNO_3 to pH <2, H_2SO_4 to pH <2	6 months

See footnotes at end of table.

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TABLE 5-1
(Continued)

PARAMETER	CONTAINER[a]	VOLUME REQUIRED (mL)	PRESERVATION[b]	MAXIMUM HOLDING TIMES[c]
o Hydrogen Ion (pH)	P,G	25	None required	Analyze immediately
o Kjeldahl and Organic Nitrogen	P,G	500	Cool 4°C, H_2SO_4 to pH <2	28 days
Metals[f]				
o Chromium VI	P,G	50	Cool 4°C	24 hours
o Mercury	P,G	100	HNO_3 to pH <2	28 days
o Metals, Except Chromium VI and Mercury	P,G	200	HNO_3 to pH <2	6 months
o Nitrate	P,G	100	Cool 4°C	48 hours
o Nitrate-Nitrite	P,G	100	Cool 4°C, H_2SO_4 to pH <2	28 days
o Nitrite	P,G	50	Cool 4°C	48 hours
o Oil and Grease	G	1,000	Cool 4°C, H_2SO_4 to pH <2	28 days
o Organic Carbon	P,G	25	Cool 4°C, HCl or H_2SO_4 to pH <2	28 days
o Orthophosphate	P,G	50	filter immediately, cool 4°C	48 hours
o Oxygen, Dissolved Probe	G bottle and top	300	None required	Analyze immediately
o Phenols	G	500	Cool 4°C, H_2SO_4 to pH <2	28 days
o Phosphorus (Elemental)	G	50	Cool 4°C	48 hours
o Phosphorus, Total	P,G	50	Cool 4°C, H_2SO_4 to pH <2	28 days
o Residue, Total	P,G	100	Cool 4°C	7 days
o Residue, Filterable	P,G	100	Cool 4°C	48 hours
o Residue, Nonfilterable	P,G	250	Cool 4°C	7 days

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TABLE 5-1
(Continued)

PARAMETER	CONTAINER[a]	VOLUME REQUIRED (mL)	PRESERVATION[b]	MAXIMUM HOLDING TIMES[c]
o Residue, Settleable	P,G	1,000	Cool 4°C	48 hours
o Residue, Volatile	P,G	100	Cool 4°C	7 days
o Silica	P	50	Cool 4°C	28 days
o Specific Conductance	P,G	100	Cool 4°C	28 days
o Sulfate	P,G	100	Cool 4°C	28 days
o Sulfide	P,G	500	Cool 4°C, add zinc acetate plus sodium hydroxide to pH >9	7 days
o Sulfite	P,G	50	None required	Analyze immediately
o Surfactants	P,G	250	Cool 4°C	48 hours
o Temperature	P,G	1,000	None required	Analyze immediately
o Turbidity	P,G	100	Cool 4°C	48 hours
Organic Tests[g]				
o Purgeable Halocarbons	G,Teflon-lined septum	40	Cool 4°C, 0.008% $Na_2S_2O_3$[d]	14 days
o Purgeable Aromatic Hydrocarbons	G, Teflon-lined septum	40	Cool 4°C, 0.008% $Na_2S_2O_3$[d], HCl to pH 2[h]	14 days
o Acrolein and Acrylonitrile	G, Teflon-lined septum	40	Cool 4°C, 0.008% $Na_2S_2O_3$[d], adjust pH to 4-5[i]	14 days
o Phenols[j]	G, Teflon-lined cap	1,000	Cool 4°C, 0.008% $Na_2S_2O_3$[d]	7 days until extraction 40 days after extractio

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TABLE 5-1
(Continued)

PARAMETER	CONTAINER[a]	VOLUME REQUIRED (mL)	PRESERVATION[b]	MAXIMUM HOLDING TIMES[c]
o Benzidines[j]	G, Teflon-lined cap	1,000	Cool 4°C, 0.008% $Na_2S_2O_3$[d]	7 days until extraction[
o Phthalate Esters[j]	G, Teflon-lined cap	1,000	Cool 4°C	7 days until extraction 40 days after extractio
o Nitrosamines[j,m]	G, Teflon-lined cap	1,000	Cool 4°C, store in dark, 0.008% $Na_2S_2O_3$[d]	7 days until extraction 40 days after extractio
o PCBs[j] acrylonitrile	G, Teflon-lined cap	1,000	Cool 4°C	7 days until extraction 40 days after extractio
o Nitroaromatics and isophorone[j]	G, Teflon-lined cap	1,000	Cool 4°C, 0.008% $Na_2S_2O_3$[d], store in dark	7 days until extraction 40 days after extractio
o Polynuclear Aromatic Hydrocarbons[j]	G, Teflon-lined cap	1,000	Cool 4°C, 0.008% $Na_2S_2O_3$[d], store in dark	7 days until extraction 40 days after extractio
o Haloethers[j]	G, Teflon-lined cap	1,000	Cool 4°C, 0.008% $Na_2S_2O_3$[d]	7 days until extraction 40 days after extractio
o Chlorinated Hydrocarbons[j]	G, Teflon-lined cap	1,000	Cool 4°C	7 days until extraction 40 days after extractio
o TCDD[j]	G, Teflon-lined cap	1,000	Cool 4°C, 0.008% $Na_2S_2O_3$[d]	7 days until extraction 40 days after extractio
Pesticides				
o Pesticides	G, Teflon-lined cap	1,000	Cool 4°C, pH 5-9[n]	7 days until extraction 40 days after extractio

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TABLE 5-1
(Continued)

PARAMETER	CONTAINER[a]	VOLUME REQUIRED (mL)	PRESERVATION[b]	MAXIMUM HOLDING TIMES[c]
Radiological Tests				
o Alpha, Beta, and Radium	P,G	1,000	HNO_3 to pH <2	6 months

Reference: This table includes the requirements of the U.S. Environmental Protection Agency, as published in the Code of Federal Regulations, Vol. 49, No. 209, 40 CFR 136, October 26, 1984, pg, 43260.

[a] Polyethylene (P) or glass (G).

[b] Sample preservation should be performed immediately upon sample collection. For composite chemical samples, each aliquot should be preserved at the time of collection. When use of an automatic sampler makes it impossible to preserve each aliquot, then chemical samples may be preserved by maintaining at 4°C until compositing and sample splitting is completed.

[c] Samples should be analyzed as soon as possible after collection. The times listed are maximum times that samples may be held before analysis and still be considered valid. Samples may be held for longer periods only if permittee, or monitoring laboratory, has data on file to show that the specific types of samples under study are stable for the longer time. Some samples may not be stable for the maximum time period given in the table. A permittee, or monitoring laboratory, is obligated to hold the sample for a shorter period if knowledge exists to show this is necessary to maintain sample stability.

[d] Should only be used in the presence of residual chlorine.

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TABLE 5-1
(Continued)

(e)

Maximum holding time is 24 hours when sulfide is present. Optionally, all samples may be tested with lead acetate paper before pH adjustment to determine if sulfide is present.

(f)

Samples should be filtered immediately on site before adding preservative for dissolved salts.

(g) Guidance applies to samples to be analyzed by GC, LC, or GC/MS for specific compounds.

(h) Sample receiving no pH adjustment must be analyzed within seven days of sampling.

(i) The pH adjustment is not required if acrolein will not be measured. Samples for acrolein receiving no pH adjustment must be analyzed within three days of sampling.

(j) When the extractable analytes of concern fall within a single chemical category, the specified preservative and maximum holding times should be observed for optimum safeguard of sample integrity. When the analytes of concern fall within two or more chemical categories, the sample may be preserved by cooling to 4°C, reducing residual chlorine with 0.008% sodium thiosulfate, storing in the dark, and adjusting the pH to six to nine; samples preserved in this manner may be held for seven days before extraction and 40 days after extraction. Exceptions to the optional preservation and holding time procedure are noted in footnote (d) (re the requirement for thiosulfate reduction of residual chlorine) and footnotes (k) and (l) (re the analysis of benzidine).

(k) If 1,2-diphenylhydrazine is likely to be present, adjust the pH of the sample to 4.0±0.2 to prevent rearrangement to benzidine.

(l) Extracts may be stored up to seven days before analysis if storage is conducted under an inert (oxidant-free) atmosphere.

(m) For the analysis of diphenylnitrosamine, add 0.008% $Na_2S_2O_3$ and adjust pH to seven to ten with NaOH within 24 hours of sampling.

(n) The pH adjustment may be performed upon receipt at the laboratory and may be omitted if the samples are extacted within 72 hours of collection. For the analysis of aldrin add 0.008% $Na_2S_2O_3$.

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TABLE 5-2

PRESERVING AND TRANSPORTING SOIL SAMPLES FOR GEOTECHNICAL ANALYSIS

TEST PROCEDURE	PRESERVATION(1)	TRANSPORTATION(1)
Classification of Soil	A	I
Consolidation	C,D	II
Direct Shear Tests (Disturbed)	B	I
(Undisturbed)	C,D	II
Grain Size Analysis	A	I
Permeability	A	I
Plasticity Index	B	I
Proctor Densities	B	I
Relative Density	B	I
Resistivity (Disturbed)	C	I
(Undisturbed)	C	II
Slurry Wall Compatibility	A	I
Specific Gravity	A	I
Swelling Tests (Disturbed)	A	I
(Undisturbed)	B	II
Triaxial Tests	D	II
Unconfined Compression Test	D	II
Unit Weight of Undisturbed of Samples	D	II
Water Content Determination	B	I

(1) Preservation

A. No special requirements - plastic pails, plastic bags - unless hazardous material, then sample must be sealed.

B. Sealed, moisture-proof containers: plastic bag or pails, glass or plastic jars, thin-walled tubes, liners, or rings.

C. Sealed moisture-proof, thin-walled tubes, liners, or rings.

D. Sealed moisture-proof, thin-walled tubes.

(2) Transportation

I. No special requirements if nonhazardous material: follow Department of Transportation regulations if hazardous material.

II. Protection against vibration, shock, and temperature extremes.

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FIGURE 5-1

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FIELD ACTIVITY DAILY LOG

DAILY LOG			
DATE			
NO.			
SHEET		OF	

PROJECT NAME	PROJECT NO.
FIELD ACTIVITY SUBJECT:	

DESCRIPTION ON DAILY ACTIVITIES AND EVENTS:

Section 5.0
Revision No. 1
Date: July 1, 1987
Page 33 of 45

VISITORS ON SITE:	CHANGES FROM PLANS AND SPECIFICATIONS, AND OTHER SPECIAL ORDERS AND IMPORTANT DECISIONS.
WEATHER CONDITIONS:	IMPORTANT TELEPHONE CALLS:

IT PERSONNEL ON SITE:

SUPERVISOR: DATE:

327-7-86

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FIGURE 5-2

VARIANCE NO._____

VARIANCE LOG

PROJECT NO._____ PAGE ___ OF ___

PROJECT NAME _____ DATE:_____

VARIANCE (INCLUDE JUSTIFICATION)

Section No. 5.0
Revision No. 1
Date: July 1, 1987
Page 34 of 45

APPLICABLE DOCUMENT:

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CC:

REQUESTED BY: _____ Date: _____

Approved By: _____ Date: _____
Project Manager

_____ Date: _____
Quality Assurance Officer

_____ Date: _____

IT CORPORATION

Project Name _____

Project No. _____

Sample No. _____

Collection Date/Time _____

Collector's Name _____

Sample Location _____

Sample Type/Depth/Description _____

_____ Preservative _____

Analyze For _____

Bottle _____ of _____ _____ Filtered _____ Nonfiltered

FIGURE 5-3

EXAMPLE SAMPLE LABEL

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CHAIN-OF-CUSTODY RECORD

R/A Control No. _____

C/C Control No. 004300

PROJECT NAME/NUMBER _____ LAB DESTINATION _____

SAMPLE TEAM MEMBERS _____ CARRIER/WAYBILL NO. _____

Sample Number	Sample Location and Description	Date and Time Collected	Sample Type	Container Type	Condition on Receipt (Name and Date)	Disposal Record No.

Special Instructions: _____

Possible Sample Hazards: _____

SIGNATURES: (Name, Company, Date and Time)

1. Relinquished By: _____

   Received By: _____

2. Relinquished By: _____

   Received By: _____

3. Relinquished By: _____

   Received by: _____

4. Relinquished By: _____

   Received By: _____

FIGURE 5-4

WHITE - To accompany samples
YELLOW - Field copy

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DATE	
TIME	
PAGE ____ OF ____	
PAGE	
PROJECT NO.	

FIGURE 5-5

SAMPLE COLLECTION LOG

PROJECT NAME _____

SAMPLE NO. _____

SAMPLE LOCATION _____

SAMPLE TYPE _____

COMPOSITE _____ YES _____ NO

COMPOSITE TYPE _____

DEPTH OF SAMPLE _____

WEATHER _____

CONTAINERS USED	AMOUNT COLLECTED

COMMENTS:

PREPARED BY: _____

INTERNATIONAL TECHNOLOGY CORPORATION

REQUEST FOR ANALYSIS

R/A Control No. 0[illegible]256

C/C Control No. _____

PROJECT NAME _____

PROJECT NUMBER _____

PROJECT MANAGER _____

BILL TO _____

PURCHASE ORDER NO. _____

DATE SAMPLES SHIPPED _____

LAB DESTINATION _____

LABORATORY CONTACT _____

SEND LAB REPORT TO _____

DATE REPORT REQUIRED _____

PROJECT CONTACT _____

PROJECT CONTACT PHONE NO. _____

Sample No.	Sample Type	Sample Volume	Preservative	Requested Testing Program	Special Instructions

TURNAROUND TIME REQUIRED: (Rush must be approved by the Project Manager.)

Normal _____ **Rush** _____ (Subject to rush surcharge)

POSSIBLE HAZARD IDENTIFICATION: (Please indicate if sample(s) are hazardous materials and/or suspected to contain high levels of hazardous substances)

Nonhazard _____ **Flammable** _____ **Skin Irritant** _____ **Highly Toxic** _____ **Other** _____ **(Please Specify)**

SAMPLE DISPOSAL: (Please indicate disposition of sample following analysis. Lab will charge for packing, shipping, and disposal.)

Return to Client _____ **Disposal by Lab** _____

FOR LAB USE ONLY

Received By _____ **Date/Time** _____

WHITE - Original, to accompany samples
YELLOW - Field copy

FIGURE 5-6

000126

3226

INTERNATIONAL TECHNOLOGY CORPORATION

FIGURE 5-7

3226

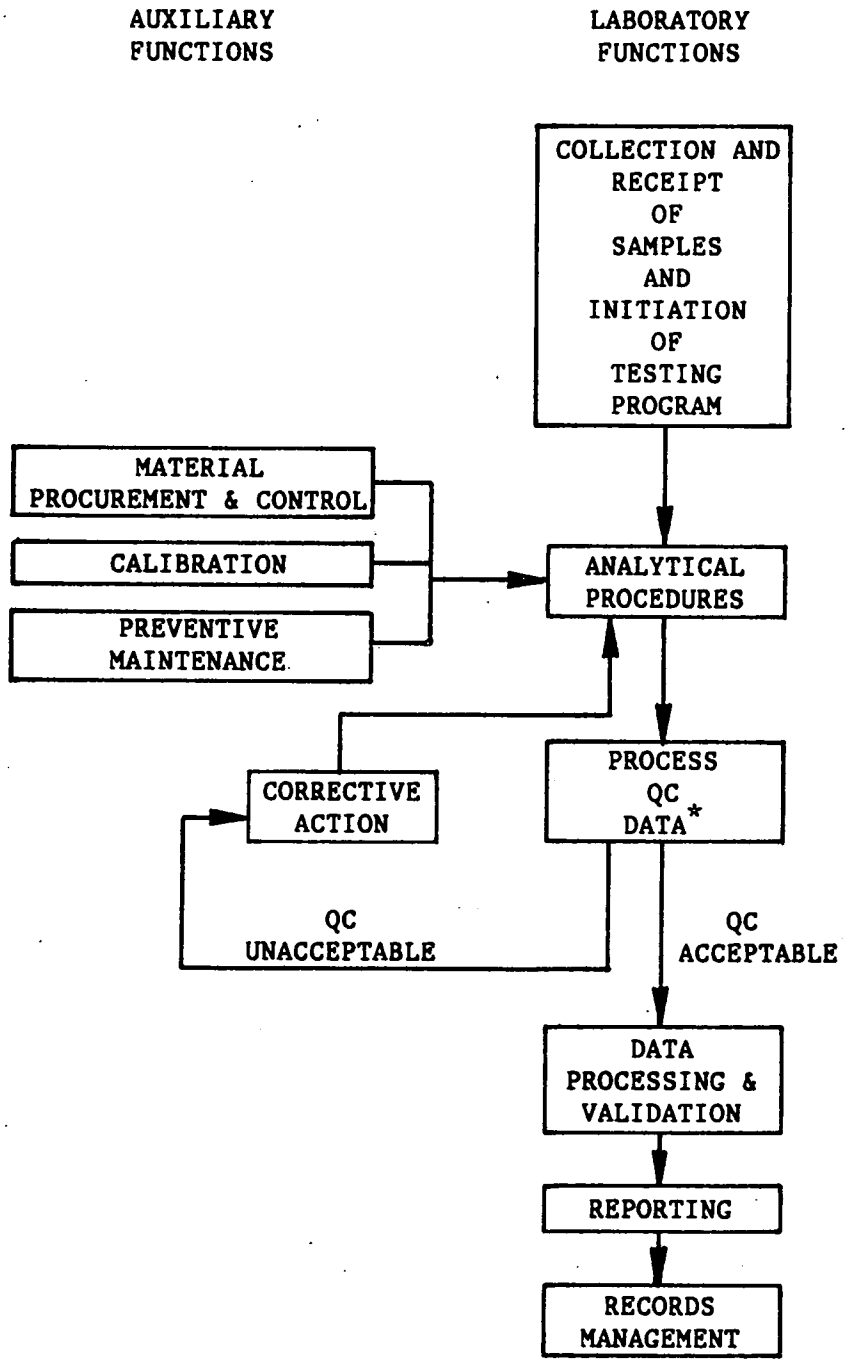
STORAGE FACILITY INVENTORY

PROJECT NAME _____ LOGGED BY _____

PROJECT NO. _____ DATE _____

STORAGE LOCATION _____

BORING OR TEST PIT NO.	SAMPLE NUMBER					DEPTH OR LOCATION	DATE STORED	DISPOSAL DATE	REMARKS
	3" TUBE	JAR	BAG	ROCK CORE					



*Chemical analysis only.

FIGURE 5-8

LABORATORY ANALYSIS FLOW CHART

LABORATORY TESTING RECORD

PROJECT NAME _____ DATE RECEIVED _____

PROJECT NO. _____ DATE COMPLETED _____

PROJECT ENGINEER _____

														REMARKS
LOCATION	BORING OR TEST PIT NO.													
	SAMPLE NO.													
	DEPTH	FROM												
		TO												
SAMPLE TYPE	3" TUBE													
	2" TUBE													
	JAR													
	BAG													
	ROCK CORE													
CLASS. TESTS	VISUAL CLASSIFICATION													
	PLASTICITY INDEX													
	SIEVE ANALYSIS													
	HYDROMETER ANALYSIS													
	SPECIFIC GRAVITY													
DENSITY TESTS	UNIT WEIGHT													
	RELATIVE DENSITY													
	PROCTOR (STANDARD)													
	PROCTOR (MODIFIED)													
	HARVARD MINIATURE													
	PERMEABILITY													
STRENGTH TESTS	UNCONFINED COMPRESSION													
	QUICK TRIAXIAL													
	CONS. DRAINED TRIAXIAL													
	CONS UNDRAINED TRIAXIAL													
	CONS. UNDRAINED TRIAXIAL WITH P.P.													
	DIRECT SHEAR													
	DIRECT SIMPLE SHEAR													
	VANE SHEAR													
	FALL CONE PENETRATION													
DYNAMIC	RESONANT COLUMN													
	CYCLIC TRIAXIAL													
	TORSIONAL SIMPLE SHEAR													
OTHERS	CONSOLIDATION													
	CONSTANT DIAMETER TRIAXIAL													
	AMOUNT SAVED													

☐ TO BE TESTED ☒ TEST COMPLETED ■ UNABLE TO RUN

SIGNED _____
PROJECT ENGINEER

FIGURE 5-10

TESTING PROCEDURE RECORD*

PROJECT NAME _____

PROJECT NO. _____

LABORATORY TEST _____

SPECIMEN _____

INSTRUCTIONS: _____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

DATE _____ SIGNED _____

*THIS RECORD IS TO BE COMPLETED BY THE RESPONSIBLE PROJECT PERSONNEL OR THE LABORATORY MANAGER TO DENOTE ALL VARIABLE QUANTITIES OR VARIANCES FROM STANDARD PRACTICE FOR A LABORATORY TEST.

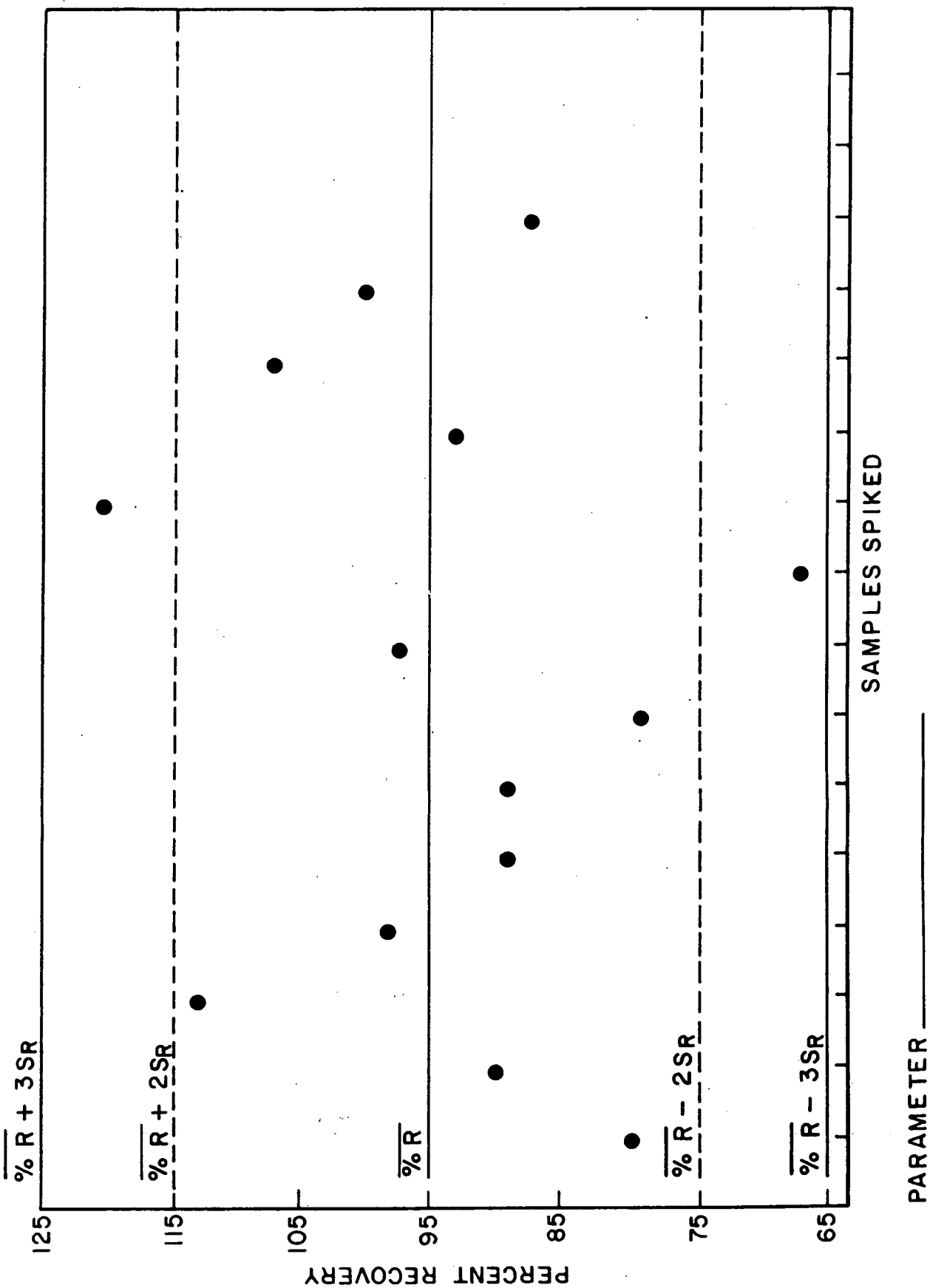


FIGURE 5-11

EXAMPLE ACCURACY QUALITY CONTROL CHART

FIGURE 5-12

LABORATORY EQUIPMENT CALIBRATION RECORD

EQUIPMENT NUMBER _____

EQUIPMENT NAME _____

_____

REQUIRED CALIBRATION PERIOD: _____

DATE CALIBRATION PERFORMED	CALIBRATION PERFORMED BY	DATE CALIBRATION PERFORMED	CALIBRATION PERFORMED BY

FIGURE 5-13

NOTICE OF EQUIPMENT CALIBRATION FAILURE

EQUIPMENT NUMBER _____

EQUIPMENT NAME _____

REASON FOR FAILURE TO PASS CALIBRATION _____

_____

_____

WAS EQUIPMENT REPAIRED OR REPLACED ? _____

_____

IF REPAIRED , WAS THE CORRECTIVE ACTION ADEQUATE ____

_____

_____

_____

_____

Signed _____

6.0 MODELING AND DESIGN

Analysis and design activities include numerical tasks which may involve the processing of acquired data, evaluation of anticipated or actual performance, estimation of costs, and prediction of future behavior. These activities are generally performed using calculations which may range from simple hand analyses to complex computer studies. Analysis and design shall be completely documented and the resulting documentation formally checked using the standard processes described in this section.

6.1 PERFORMANCE

Analysis and design activities shall be performed in a planned and controlled manner. Where appropriate, documented and approved procedures shall be employed.

Performance responsibility rests with the Project Manager. Prior to initiating the activities, the manager should discuss the scope of the work, contractual and regulatory requirements, and applicable Quality Assurance/Quality Control procedures with assigned personnel. At the request of the Project Manager this may be done by Quality Assurance personnel or senior members of the Project Staff. It is emphasized that the Project Group is responsible for the daily Quality Control activities associated with analysis and design.

6.2 PERFORMANCE DOCUMENTATION

To provide evidence of satisfactory work performance and the basis for information transmitted external to IT, estimates, analyses, and designs and their results shall be completely documented. Documentation may include calculations, computer programs and associated input/output, logs, drawings, and tables.

6.2.1 Calculations

For many projects, calculations represent the most important source of information when the work is completed. They shall be legible and in a form suitable for reproduction, filing, and retrieval. Documentation shall be sufficient to permit a technically qualified individual to review and understand the calculations and verify the results.

Calculations shall be performed on IT standard calculation paper whenever possible. Exceptions to this are items such as computer output and graphs drawn on oversized paper. All calculation pages shall be individually identified with the exception of large computer output. IT calculation paper provides spaces for the originator's name and date of work, the checker's name and date, calculation subject, project number, and page number. All of this information shall be completed for each page in a uniform manner. For extra pages, such as large graphs, this information shall also be included.

Calculations should, as appropriate, include:

- Statement of calculation intent
- Discussion of modeling requirements
- Description of methodology used
- Assumptions and their justification
- Input data and equation references
- Numerical calculations, including units
- Results.

Referencing input data, particularly data obtained externally, is extremely important as it provides the basis for calculation checking. If initial parameters are supplied by an external source, the source shall be documented. Data that are provided by telephone shall be documented using an IT telephone record sheet. A request shall be made for formal written confirmation of critical data to serve as the final documentation. Input data may provide:

- Design code or regulatory requirements
- Performance and operational requirements under various conditions
- Data previously generated for a specific site or region (e.g., geological, hydrogeological, geochemical, geotechnical, meteorological, seismological, and man-made facilities and practices)
- Data previously generated for specific materials or chemical compounds (e.g., physical, chemical, geochemical, mechanical, thermomechanical, and toxicological)
- Loadings
- Results of field and laboratory testing or other calculations
- Other information obtained from the client or literature/information surveys.

Computer printout that becomes an integral part of the calculations shall be referenced in the calculations by run number or other unique means of identification. Short computer runs and spread sheets can be directly incorporated into the calculations by affixing the output to IT paper or directly including output of standard sheet size (8-1/2 by 11 inches).

At the end of a calculation, the results should be summarized, if this will provide clarity. Also, all pages shall be consecutively numbered. On IT calculation pages, the page numbers of individual calculations shall be completed with the indexing of sheet ___ of ___. For the compilation of a set of calculations, the combined set should be consecutively numbered in the circles in the upper right corner of the calculation pages.

Calculations which are preliminary in nature (i.e., those not contributing to final project information) shall be marked "preliminary." If "preliminary" calculations are retained for future reference, each page shall be clearly marked "preliminary." Quality control requirements associated with final calculations, such as checking, are not applicable to "preliminary" work.

Calculations which are superseded or replaced shall be marked "void" or destroyed. If "void" calculations are retained for future reference, each page shall be clearly marked "void" and the calculations should include, as necessary, an explanatory note as to why they are "void." The explanatory note shall be signed by the originator.

6.2.2 Computer Programs

Computer programs used by IT should be documented in sufficient detail to satisfy project requirements and needs and the intended use of the program. An interactive program (e.g., spreadsheet) developed on a personal computer for the one-time solution of a numerical equation requires less documentation than a large batch-oriented program (such as a finite-element program) used repeatedly for many projects. For this reason, a case-by-case determination of required documentation shall be made by the program originator/user and approved by appropriate management and, if necessary, Quality Assurance personnel. Information to be documented shall be selected from the items presented in this section.

Program documentation serves several functions, including:

- Providing operating instructions for the program
- Detailing the theoretical basis for the program computations
- Providing a reference source for the individuals checking program input and use
- Providing sufficient information to allow modification of the program.

Documentation is divided into three major sections: user-oriented information, programmer reference information, and the program abstract. User-oriented information may consist of user reference material (e.g., a user manual) and program theory material (e.g., a theory manual). Programmer reference material may consist of a program listing for the latest revision,

lists showing changes to the program for each revision, a flow chart, and other programmer information. Program reference material is relevant especially to programs on internal IT computer systems. The program abstract notifies a user of the status of the program; this includes: verification status, revision number, system on which it operates, and knowledgeable users. The abstract also may provide a summary of the program capabilities. Abstracts will provide fast, accurate access to information concerning corporate computer capabilities.

An outline of potential program documentation is as follows:

User-Oriented Information (Reference Material)

- Program Name and Brief Descriptive Summary* - The program name is often an acronym for the program description. A brief descriptive summary should follow, relating: how the program is utilized and what it does, what are the major theories and assumptions that it includes, what are the theoretical limitations of the program, and what options and features are available.

- System - The computer system on which the program operates. If external, vendor and IT facilities through which the program is accessed should be listed.

- Author - If the program is internal, the author is defined as the IT employee or employees responsible for development. Development is the determination of program specifications as well as coding of computer language. If external, the company or organization which originated the code, or principal investigators should be listed as the author.

*Minimum documentation requirements which shall be satisfied for computer programs employed by IT. This documentation may be in the format presented in this section or it may be supplied in any convenient form based on the needs of a particular group, project, or calculation.

- Verification Status - An indication that the program has been partially or wholly verified should be provided. If the program is partially verified, the specified options or input combinations for which the program has not been verified should be identified.

- Quality Assurance Approval - Approval consists of a statement that the documentation and verification have been approved by Quality Assurance personnel. Approval implies that the program meets the Quality Assurance Program standards for verification and documentation.

- Program Considerations - A description of the function of each major option, the purpose of each subroutine, how data are stored during computation, and any restart capabilities should be given. Error messages which are printed as a direct result of statements internal to the program should be presented and explained.

- Data Files - A description of the general content, purpose, and organization of each data file should be given. How and when the files are read and written by the program and the use of any auxiliary programs which create, modify, or use the files should also be described.

- Input Description - Input variables and input format should be described in a manner such that they are clear and complete to a user who is familiar, in a general way, with the usage of the program.* Where program options are involved, different options often require different data input and in such cases the input format for all data options should be specified. Often the input data will not be obvious from the theoretical development section. Each piece of data should be fully described (e.g., definition, any default value, acceptable limits, physical representation, and units) in the order in which it occurs in the input. If the program is able to retain input data from previous cases, give the conditions for retention.

- System Interface - Required compilers, special load options, control cards or command files, and amount of processing time to run the program should be specified.

- Output Description* - The output format should be described such that it is clear and complete to a user who is familiar, in a general way, with the program.

- Reference - The user material should mention the abstracts (described below) as a source of the most current information about the program.

User-Oriented Information (Program Theory Material)

- Program Theoretical Development - The complete, relevant theoretical basis for the program should be presented. This may include:

  - For each component model (i.e., a logically distinct subset of the overall program model), the purpose and scope, assumptions and limitations, mathematical symbols used and computer variable associated with each symbol, and location within the program.

  - For each component model and numerical method, the reference source or a step-by-step derivation beginning with generally accepted principles and ending with the final form of the model or method.* The theories, formulas, or routines that are specific to the program should be presented on calculation paper in a similar manner to calculations with all references cited in complete detail. The material should be independently checked using standard IT procedure (Section 6.3.1). When the theories, formulas, or routines have been taken from a published source, copies of this information may be presented or the source referenced.

  - For each numerical method (i.e., a procedure for solving a problem primarily by a sequence of arithmetic operations), a discussion of stability and accuracy.

  - For the overall program, descriptions of the program solution process, roles of each component model, and solution strategy and computational sequence of the numerical solution.

- Sample Problems - Sample problems should be presented if the program is sufficiently complex to warrant their inclusion. Sample problems should be of a general and illustative nature and should include a description of the problem, the source of pertinent input, an input listing, and the corresponding program output.

In the case of external programs, it generally will not be possible to provide program theory information in the detail desired. Externally prepared material pertinent to theoretical development should be presented as an alternative.

Programmer Reference Information

The information presented here is intended to aid the programmer in maintaining and updating the computer program:

- Program Revisions - The following items should be included as part of the verification (Section 6.3.2) but should also be maintained to aid in the diagnosis of program problems and to aid in making revisions: a log sheet (e.g., Verification Master Log [Figure 6-1]) listing each revision, author, the date of that revision, the content of/reason for the revision, the individual(s) who verified the revision and the date of verification; and a record of each set of updates made for each new revision.

- Program Flow Chart - A flow chart aids in program diagnosis and should be presented if possible. As a substitute, a marked up listing with descriptions in the margin may be provided. If a flow chart is presented, standard symbols should be used.

- Variable Dictionary - A listing of input and output variables and their physical equivalents should be provided. If these definitions have already been sufficiently explained in the User Oriented Information, this item may be omitted.

- Input-Output Files Other Than Printed Output - All data stored on temporary or semi-permanent storage at an internal or external usage area should be identified. This should include all parameters which are necessary to read a tape. If a program revision requires alteration of such a file, the change should be noted and fully documented.

- System - The computer system on which the program was developed should be defined.

- System-Dependent Routines or Properties - These items should be identified to ease transfer of the program between systems.

Program Abstract

Items which may be required for the abstract (Figure 6-2) of a computer program are as follows:

- Program Name

- Category - The general subject area (e.g., geotechnical, environmental, and hydrogeological) of the program should be cited.

- Revision Number and Date - The date and number of the latest revision for internal programs, or date and most recent update or modification for external programs, should be specified.

- Nature of the Problem, Method of Solution, and Features - This information should be available in the Brief Descriptive Summary defined earlier under user-oriented information. Answers to the questions "What is solved," "How is it solved," and "What are special aspects of the solution?" should provide content for these three items.

- Related Programs - This item should include pre- and postprocessors, such as plotting programs, and especially previous versions of the program, if it has been renamed.

- Installation - Installation refers to the system on which the program is operable.

- Language - This is the programming language used to write the program.

- QA - The date of Quality Assurance approval of the program, if any, should be presented.

- Origin - Origin of the program (e.g., in-house, outside vendor, government agency, or university) should be stated.

- Program Verification - The location of program verification material should be given. If the verification was done for a program intended for one-time use on a project, the project number should be given here.

- Author - The person(s) who determined problem specifications and was responsible for program development is the author.

- Knowledgeable Persons - A list of IT personnel who are experienced users, checkers, or reviewers of the program should be given.

- User/Theory Manuals - The availability of these manuals should be indicated.

Program documentation should be maintained by Computer Services personnel for programs whose use is not limited to one project. Documentation should be filed by program name, with materials from all revisions retained.

Project-specific programs should be documented as other programs, but the documentation should be maintained in the project files. This information may be maintained as a separate file or incorporated directly with associated calculations.

6.2.3 Computer Program Output

The results of any computer analysis shall be completely documented, regardless of the nature of the analysis or the computer used. Each analysis output shall be clearly identified as to project number, program name, analysis title, unique identification number or time (only for output from large computer systems), user's name and date performed, and checker's name and date. The complete output, showing all input and results, shall be printed and either directly incorporated into calculations or kept separately with the project records. When a project is completed, or at intermediate stages depending on the phases of the work, large sets of computer output should be placed in binders having a table of contents. If it is necessary to void computer runs because of changes in model or input parameters, the output

shall be destroyed; or marked "void," and an explanatory note included, if appropriate.

6.2.4 Logs, Drawings, and Tables

The results of analysis and design activities may be presented in logs, drawings, and tables of various forms. The format of logs, drawings, and tables shall be governed by the information to be presented and the IT Manual of Practice, "Drafting and Graphics Standards Manual." Drawings shall be prepared as a joint effort of Drafting personnel and the Project Group. The primary identification for a drawing is a unique drawing number which is maintained even though the drawing is revised or altered in the future. Drawing numbers and titles will be recorded in a drawing logbook maintained by the drafting group. A sample page is shown in Figure 6-3. Report figure number and title may be used as secondary identifiers. Standardized symbols and IT drafting standards shall be used. If a nonstandard symbol is used, it shall be defined on the drawing. References to other drawings and sources of information shall be provided, as necessary, and the drawing revision status clearly indicated.

Drawings shall be signed and dated by the draftsperson performing the work, the drafting checker when appropriate, and the responsible member of the Project Group who has checked the drawing (Section 6.3.5). It is the responsibility of individuals who have checked the drawing to personally sign the drawing original. The only exception to this shall be if these individuals are out of the office and have specifically requested their initials be applied to the drawing.

Revisions shall be noted on the drawing original with a revision number and a brief note describing each revision. The note shall be signed and dated by the draftsperson performing the work and the responsible member of the Project Group who has checked the revision.

Indication of final drawing and revision approval shall be through signing and dating of the drawings by the responsible Operations Manager, Project Manager, or member of the Project Staff delegated this responsibility by the Project Manager. Approval does not indicate checking, but only approval for issue.

6.3 VERIFICATION

Calculations, computer programs and associated input, logs, drawings, and tables shall be formally verified (checked) using the standard IT processes. Verification shall be prior to the presentation of associated results or their use in subsequent activities. If it becomes necessary to present or use unverified work, transmittals or subsequent calculations shall be marked "preliminary" until such time that the work is checked and determined to be correct.

6.3.1 Calculations

For calculations, the standard IT checking process is outlined as follows.

Assignments for checking shall be made or approved by the Project Manager. Verification shall be performed by an individual(s) other than the person who performed the original work or specified the method or input parameters to be used. The individual(s) selected shall have the technical expertise in the calculation subject necessary to verify, as appropriate, that:

- Applicable design code, regulatory, and technical requirements have been properly identified and referenced and that these requirements have been met
- Appropriate modeling and calculational methodology have been used
- Assumptions have been adequately described and, when necessary, justified
- Input parameters have been correctly selected and incorporated into the calculation

- Information and equations from external sources have been referenced
- Numerical calculations are correct and have been completely documented
- Results are reasonable considering the inputs.

It is emphasized that a numerical check is not sufficient. The checker is responsible for every item on every sheet--including the completion of the title block and page numbers. The importance of a complete and thorough review cannot be overemphasized.

To properly check calculations:

- The originator supplies the designated checker with a machine copy of the calculations. Originals should not leave the originator's possession until they are ready for final checker signing.
- The checker marks the calculation copy with a yellow marker for all items he approves.
- If the checker disagrees, for any reason, the checker crosses through the item with a red marker and writes the recommended correction or comment above it.
- The checker signs and dates all pages of the checkprints.
- The checker returns the checkprints to the originator who, in turn, reviews all recommended changes. Agreed-to corrections may be marked with a check of a third color. If a disagreement still exists, the originator adds comments to the checkprints using the third color, initials and dates the checkprints, and then confers with the checker until all differences are resolved.
- The originator corrects, or "scrubs," the calculation originals so they agree with the checkprints. A one-to-one correspondence between the originals and checkprints must exist.

- The originator gives the originals and checkprints to the checker who compares them to verify all agreed-to corrections have been made.

- When the checker is satisfied, the checker signs and dates the originals.

Checkprints shall be maintained as a part of the project file, of equal importance as the originals.

Under no circumstances shall calculations be altered after final signature by the checker. If it becomes necessary for calculations to be revised, the new pages shall be formally checked as described above.

6.3.2 Computer Programs

Each computer program used by IT shall be verified as necessary to satisfy project requirements and needs and the intended use of the program. Programs from one-time codes run on a personal computer to large, repeat-usage, finite-element codes will require different levels of verification. For this reason, a case-by-case determination of required verification shall be made by the program author, user, and/or checker and approved by appropriate management. Approval may also be required by Quality Assurance personnel. The verification procedure shall be developed from the items presented in this section.

Verification is the process by which output results of a computer program are determined as "correct." Verification implies that the program solves the numerical problem as intended by the author. Whether or not the program theory is a correct representation of the process or system for which it is intended (validation) is also considered to be part of verification. In-house computer programs and purchased, unverified, external programs shall be verified in one, or a combination of, three ways:

- Independent hand calculations can be performed to verify program results. Such calculations should be performed and checked in accordance with Sections 6.2.1

and 6.3.1. Calculations should be checked to verify that assumptions and results are in accordance with those used in the program.

- The program results can be compared to the results of an "independently developed" program which performs the same calculation. Independent development could mean a program developed outside IT or by a different internal group. If possible, a program should not be checked against a second program developed by the same people responsible for the first program unless the methodology is totally different. The input to both the program being checked and the program used for checking should be independently checked (Section 6.3.3). The comparison should include consideration of the respective program documentations.

- The program results can be compared to analyses published in textbooks and journals or the results of testing activities. A complete reference for such material should be provided. This method includes comparison against closed-form solutions.

Verification of a program should be performed by members of the professional staff. The content of a computer program verification should include:

- Verification Master Log - This is a record of a program's revisions and of its verification status. (Items which should be included are: date of revision, revision number, persons performing revision and verification or reverification [if necessary], date of verification, reason for revision, content of revision, person logging the information, and date of log entry).

- Description and Explanation of What Was Done to Verify the Program - This identifies what independent options of the program were verified,* and should include error message options and default options as well as regular program options.

*Minimum verification requirements which shall be satisfied for computer programs employed by IT. Verification may be in the format presented in this section or it may be supplied in any convenient form based on the needs of a particular group, project, or calculation.

- Set of Verification Comparison Material: Hand Calculations, Computer Runs, Test Program Results, and/or Textbook and Journal References* - These are the actual documents which show the results that are being compared to the program which is being verified.

- Program Computer Verification Runs for the Options Being Verified* - These should be the original runs, giving results which will be compared to the documents listed immediately above.

External programs, which are widely used and documented with sample problems and are considered "industry standards," do not require IT verification. However, these programs, when brought into IT and put onto an in-house computer system without alteration, should be tested to demonstrate correct operation (e.g., by duplicating standard sample problems). Every effort should be made to obtain documentation of user and programmer reference material and verification activities.

Program verifications should be maintained by Computer Services personnel for programs whose use is not limited to one project. Verification material should be filed by program name, with material from all revisions retained.

Project-specific programs should be verified as other programs, but the verification should be maintained in the project files. This information may be either maintained as a separate file or incorporated directly in associated calculations. The review of the verification should be performed by the Project Staff as part of the normal input checking process (Section 6.3.4).

6.3.3 Spreadsheet Applications

Spreadsheet programs will normally be considered "Industry Standards" and thus are accepted as verified. Spreadsheet applications must be verified.

Spreadsheets that serve as templates for multiple use can be verified with a set of "dummy" data or compared to hand calculations and then used with future checking limited to input verification (Section 6.3.4).

Spreadsheet applications that will have a one-time use may be checked using the "real" data and compared to a hand calculation of the same data. Hand calculations must be checked in accordance with Section 6.3.1.

The verification file for a spreadsheet application must include:

- File name and brief description of what the program does
- Formulas, method, logic, and assumptions used in the construction of the spreadsheet (including printed spreadsheet with cell formulas and input sources, e.g., cost data)
- References for formulas, theory, and data
- Description of method used to verify the spreadsheet
- Set of verification comparison materials (e.g., checked hand calculations)
- Verification run, i.e., checked copy of the computer output.

6.3.4 Computer Program Input

Computer input shall be formally checked using the standard IT process outlined in Section 6.3.1. A single exception to this process is that, at the option of the Project Group, the checking may be performed on the input originals. Verification (checking) shall include a conceptual review of the program itself based on the problem being solved, a review of the computer model employed, a check that the program has been verified, and a formal check of the input data.

6.3.5 Drawings

The checking of drawings is the joint responsibility of the Project Group and Drafting personnel. Drafting personnel shall be responsible for drafting presentation, while the Project Group shall check the drawing for technical correctness. Project personnel cannot waive this responsibility. Drawings shall be checked like calculations (Section 6.3.1) using yellow and red markers.

Drawings are divided into two categories: those which present only information and those which present design-related material. Drawings considered as "information only" may be checked by the member of the Project Group who originated the drawing. Drawings which present design-related material shall be checked by an independent party capable of verifying all aspects of the design.

"Information only" drawings are in general those prepared to present project data. Included would be the presentation of laboratory test data, boring section profiles, maps, etc. Also included are maps and data prepared external to IT, provided that the external information is properly referenced to its source.

Design-related drawings are in general based on the results of calculations. Such drawings would be detail drawings which are prepared for construction specifications, construction sequence, etc. In most cases, the information shown on the drawing should be directly traceable to calculations. Therefore, in checking the drawing, it is expedient for the individual who has checked the calculations to also check the drawing. In reality, the drawing is only an extension of the calculations.

Design-related drawings which are based on judgment or are a conceptual presentation (e.g., excavation drawings) shall also be independently checked unless the drawing is clearly marked "for information only" or equivalent.

Judgment or conceptual drawings which are intended to present the final IT statement of a subject must be independently reviewed.

Because the checking of drawings is actually a Quality Control concern, the decision as to whether a drawing requires independent review shall be made by the Project Manager and be subject to review by Quality Assurance personnel. The Project Manager may delegate this responsibility to other members of the

Project Staff. The person who signs the drawing as the checker will, therefore, be the actual member of the Project Group who has checked the drawing not necessarily the originator.

Checkprints of the same drawing shall be marked CP1, CP2, etc., to show progression of the checking process. As an alternate to keeping a series of checkprints, only the final checkprint need be maintained if this checkprint shows evidence that the entire drawing has been completely checked.

If a drawing is revised, the entire checking process shall be repeated for the revised areas only. A new series of checkprints (CP1, CP2, etc.) shall be prepared. Under no circumstances shall revisions be made without the formal checking procedure.

6.3.6 Logs and Tables

Final subsurface logs, as prepared by the Project Staff and Drafting personnel shall be verified by the responsible member of the Project Staff. The checking of logs shall verify that changes from the original field logs to the final log sheets are consistent with the results of the laboratory testing or other investigations. The final log sheets shall be checked in the same manner as calculations or drawings, with the checker signing and dating all checkprints.

Tables containing information, data, or the results of analyses which are presented correspondence and reports shall be checked using the standard IT process (Section 6.3.1). Tables shall be checked against the source of the data, not the handwritten copy which is used by Word Processing, unless the handwritten copy has been checked. Because tables are used only to present information, they can be checked by the individual originating the table.

As for drawings, checkprints of the same log or table shall be numbered CP1, CP2, etc., to show the progression of the checking process.

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INTERNATIONAL TECHNOLOGY CORPORATION

REVISION/VERIFICATION MASTER LOG

PROGRAM ____________________

REV. NO.	DATE REVISED	REVISED BY	REASON/CONTENT/COMMENTS	DATE VERFIED	VERIFIED BY	DATE LOGGED	LOGGED BY

FIGURE 6-1
VERIFICATION MASTER LOG

FIGURE 6-2

SAMPLE COMPUTER PROGRAM ABSTRACT

PROGRAM: CATEGORY:

REVISION NUMBER: DATE REVISED: / /
NATURE OR PROBLEM:

METHOD OF SOLUTION:

FEATURES:
RELATED PROGRAMS:
INSTALLATION:
LANGUAGE: Q.A.: / /
ORIGIN: PROJ VERIF:
AUTHOR:

KNOWLEDGEABLE PERSONS

-MATERIAL- -LOCATION-

LAST UPDATE ON THIS RECORD: / /

****

INTERNATIONAL TECHNOLOGY CORPORATION

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PROJECT NO.

PROJECT TITLE

CLIENT

DRAWING SIZE X

DRAWING NO.	OVERLAY NO.			FIG. NO.	DRAWING TITLE

FIGURE 6-3
DRAWING NUMBER LOG

7.0 CONTROLLING PROJECT CHANGES

Change from the original scope of work and plans is part of virtually every engineering project. Change does not imply a nonconformance to the work (as discussed in Section 8.0) but simply means that original plans must be altered because of information or events that occur during the work. Changes can have no effect on the final work product, or they can require redirection of the work so that a different end product is reached.

Throughout this Manual, the means for documenting change are noted such as daily activity logs, variance logs, testing procedure records, revisions to work plans, and change orders.

Change must be documented, evaluated, and, if necessary, reported. As stated in Section 1.2, control and continuity must be maintained throughout a project. Changes are the severest test for maintaining these factors. It is necessary to manage change so that the actual course of the project, not the original plan, can be demonstrated and justified.

Changes may not be significant to the outcome of a project (such as changing the number of borings drilled or the number of samples collected), or they may effect the direction or result of a project (such as the determination that a proposed technology is not feasible, or that as-built drawings must be prepared to demonstrate how remediation was achieved rather than as how it was planned). In all cases, changes must be documented so that the actual course of work is known and the effect of the change upon the course of work can be evaluated.

It is the responsibility of project personnel to appropriately record the change (such as a variance log) and notify the Projects Manager. The effect of the change upon the project shall be evaluated by the Project Manager.

During evaluation, the Project Manager shall consider whether the change affects the scope of work and project plans. If so, the change shall be reported as soon as possible to the client and/or regulatory agency. Reporting shall include, as appropriate, the effect of the change upon schedule, cost, the course of work, and the final result. For projects that have a scope of work defined by an IT proposal or client contract, it is imperative that the scope of work be revised to reflect the work as actually performed.

A change in scope that impacts the project cost and/or schedule, whether requested by IT or the client, shall be brought to the attention of the Project Manager at once. The Project Manager shall document the request, including projected changes in cost and schedule. The Project Manager shall submit a formal request for a change order to the client. The change order request may take the form of a letter, an amendment to the contract, or a standardized form may be developed to meet the needs of the project or office. The change order must be approved by both IT and the client.

8.0 NONCONFORMANCE/CORRECTIVE ACTION

Nonconforming items and activities are those which do not meet the project requirements, procurement document criteria, approved work procedures, or accepted IT standard practice. Nonconformances may be detected and identified by:

- Project Personnel - During the performance of field operations, supervision of subcontractors, performance of field inspection, and preparation and verification of numerical analyses and designs
- Laboratory Personnel- During the preparation for and performance of laboratory testing, calibration of equipment, and Quality Control activities (ITAS Quality Assurance Manual, Section 13.0).
- Quality Assurance Personnel - During the performance of audits (Section 11.0) and other quality assurance activities
- Subcontractors - During performance of subcontracted services.

Nonconformances are not variances (Section 5.2.3). Variances are approved and controlled changes to an approved plan or procedure. The variance is to be approved prior to implementing the change. Nonconformances are uncontrolled and unapproved deviations from an approved plan or procedure.

Each nonconformance* affecting quality shall be documented by the personnel identifying or originating it. For this purpose Notice of Equipment Calibration Failure (Figure 5-13 and Section 5.5.7), results of laboratory analysis Quality Control tests, post audit report, inspection report, internal memorandum, or letter shall be used as appropriate. Alternately, the form shown in Figure 8-1 can be used for the reporting of any nonconformance.

*For the purpose of this Manual, nonconformances include malfunctions, failures, deficiencies, and deviations.

Figure 8-1 provides examples of responses for the requirement, nonconformance, and corrective action descriptions. Documentation shall, when necessary, include:

- Identification of the individual(s) identifying or originating the nonconformance
- Description of the nonconformance
- Required approval signatures
- Method(s) for correcting the nonconformance (corrective action) or description of the variance granted
- Schedule for completing corrective action.

Documentation shall be made available to IT Project and laboratory management, Quality Assurance personnel, and/or subcontractor management. For example, the Project Manager and appropriate Quality Assurance personnel shall be notified of any nonconformance and subsequent corrective action taken by the Project Staff as part of their Quality Control activities. This includes any deviations from standard practice or testing techniques as well as deficiencies that occur.

It is the responsibility of the Project Manager, Laboratory Manager, and/or Quality Assurance personnel to notify appropriate IT personnel of the nonconformance. In addition, the Project Manager should notify the client of significant nonconformances which could impact the results of the work and indicate the corrective action taken or planned.

Completion of corrective actions for nonconformances should be verified by Quality Assurance personnel as part of future auditing activities.

Any recurring nonconformance should be evaluated by Project, Laboratory, and/or Quality Assurance personnel to determine its cause and appropriate changes instituted in corporate or project requirements and procedures to

prevent future recurrence. When such an evaluation is performed, the results shall be documented. If quality-related documents are revised, revision shall be performed as discussed in Section 3.0.

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FIGURE 8-1

NONCONFORMANCE REPORT

PROJECT NO. _____ PAGE ___ OF ___

PROJECT NAME _____ DATE: _____

NONCONFORMANCE:

IDENTIFIED BY: _____ DATE: _____

CORRECTIVE ACTION REQUIRED:

TO BE PERFORMED BY: _____ DATE: _____

MUST CORRECTION BE VERIFIED? YES ___ NO ___

TO BE VERIFIED BY: _____ PREPARED BY: _____ DATE: _____

CORRECTIVE ACTION TAKEN:

PERFORMED BY: _____ DATE: _____

VERIFIED BY: _____ DATE: _____

CC:

Approved By: _____ Date: _____

_____ Date: _____

9.0 REPORT PREPARATION

The Project Manager is responsible for the preparation, review, and submittal of IT reports for each project. It is this individual's responsibility to provide a report that fulfills the scope of work, meets contractual conditions, and satisfies applicable regulatory and internal IT requirements. The guidance presented in this section shall apply to reports prepared for external clients and reports prepared internally for IT purposes and use.

9.1 TYPES OF REPORTS

The type of report prepared should be determined by the work performed, contractual and regulatory requirements, and the end use of the report. Typical reports include:

- Project plans
- Remedial investigations/feasibility studies
- Permit applications
- Design reports
- Responses to regulatory questions
- Site characterizations
- Computer program user and theory manuals
- Data reports.

Reports may be issued as "preliminary" or "draft," or as "final" presentations of the work. Preliminary or draft reports are generally issued for review and comment by the client or regulatory agency. This type of report shall be reproduced on paper which states "preliminary" or "draft" on each text page, table, figure, and appendix. As an alternate, the letter of transmittal and report cover may be used to indicate report status.

For the purposes of the Engineering Operations Quality Assurance Program, "preliminary" and "draft" are defined as:

- Preliminary - Documents that have been marked "Preliminary" are not fully checked. The checking process includes the document and the supporting materials, e.g., field data, laboratory data, and calculations.

- Draft - Documents that have been marked "Draft" have not completed the final review process by IT, the client, and/or the regulatory agency.

9.2 METHOD OF PREPARATION

For each report the Project Manager, or designated representative, shall:

- Determine the content of the report based upon the project scope of work, client requirements, and regulatory requirements
- Determine the report format
- Assign personnel to prepare the various items required for the report
- Distribute to the Project Staff information pertinent to their preparation activities and update this information as required
- Coordinate with the various groups within IT who may be working on the report such as the Laboratories, Word Processing, and Drafting
- Assign personnel as needed to review the work prepared for the report.

The flow chart presented in Figure 9-1 shows the suggested sequence of report preparation activities. While individual regulatory agencies and clients may have specific formats in which they require reports be prepared, reports shall, in general, contain the following items in the order presented:

- Table of Contents - Should specify the first page number of the List of Tables, List of Figures, List of Appendices, each section of the report text, and the List of References.
- List of Tables - Should sequentially identify by number and title the tables referred to in the text.
- List of Figures - Should sequentially identify the figures referred to in the text by report figure number or drawing number, and title.

- List of Appendices - Should identify each appendix by a letter designation and title.

- Report Text - The report text should consist of an introduction, the body of the text, and a section that summarizes the project work and report and cites conclusions and recommendations. The body of the text must be formulated based on the project scope of work, contractual requirements, and the intent of the report.

  The introduction should identify and describe the purpose for which the project was undertaken. It should briefly discuss IT activities pertinent to the report subject. These may include: field work; consultations with the client, regulatory agencies, and others; laboratory testing; collection of data from other sources; analysis and resulting conclusions; and the formulation of recommendations.

  The body of the report should describe the project in detail. IT and subcontractor work relating to the report subject should be discussed. The findings of field explorations and testing, literature searches, external consultations, and observations should be included. The laboratory testing program should be described and its results should be discussed. The analytical procedures employed and designs formulated should be indicated. The results of work performed should be discussed in detail and must be traceable to the project records.

  The final section of the text should summarize the purpose of the project, and IT's undertakings towards meeting that purpose. It should emphasize the results of the work and any conclusions or recommendations reached.

- List of References - Included should be the references cited in the report text whether they be external data, publications, or correspondence. The references should include the author's name, title of the publication, publisher, location of the publisher, and date, if the reference is a publication. If the reference is correspondence; the subject, date, names of the parties contacted, and type of correspondence should be included.

- Tables - Tables are generally included as a separate section following the List of References, but may be included with each section of the text. Tables are used to present groups of information in an orderly manner. Each table should have a title and a number. The information listed in the table should be clearly labeled. Particular care should be taken to include necessary references, symbols, and reporting units so that a table is "self-standing" (it does not depend upon the text for use).

- Figures - Figures are graphical presentations used to aid in the presentation of concepts to the readers of the report. They should be identified with a report figure number and/or an IT drawing number, and a title. Figures may be included as a separate section following the tables, or with each section of the text. As for tables, figures should be "self-standing."

- Appendices - Appendices include supplementary information pertinent to the report subject. Often the information contained in an appendix is technical in nature and is included in the report to provide details of topics discussed in the text. Each appendix should be identified by a letter of the alphabet. Pages within the appendix should be in logical sequence, but need not be numbered unless a sequence cannot be reasonably maintained without page numbers. Page numbers of an appendix should all begin with the letter designation of the appendix, followed by the number of the page within each appendix. The numbers begin with 1 for each appendix, such as A-1 . . ., B-1 . . ., etc.

It is emphasized that the above format is a generalized outline to be followed in report preparation. Other formats are acceptable (e.g., letter report). Whenever a regulatory agency or client requires a specific format, that method of presentation shall always take precedence.

9.3 REVIEW

Prior to issuance of a final report, it shall be reviewed by knowledgeable members of the Project Staff and the Project Manager, or designated representative. This review shall address whether:

- The report satisfies the scope of work, client requirements, and pertinent regulatory requirements.
- Assumptions are clearly stated, justified, and documented.
- A reference is cited for any information utilized in report preparation that was originated outside the project.
- The report correctly and accurately presents the results obtained by the project work.
- The tables and figures presented in the report are prepared, checked, and approved according to IT requirements.
- The report figures and drawings are signed and dated by the appropriate members of the Project Staff and Project management.
- The bases for the recommendations and conclusions presented in the report are clearly documented.
- The report has been proofread and punctuation, grammar, capitalization, and spelling are correct.

Reviews will be all documented in accordance with the Environmental Projects Group Technical Procedure - Report Review Procedure. This procedure is included in the Environmental Projects Group Policies and Procedures Manual.

In addition to review by the Project Group, specific reports may undergo a peer review process (Section 4.5). Peer review should be considered for all reports and is recommended for those which present state-of-the-art technical activities, regulatory review, or the results of projects having great potential for litigation. The peer review process is intended to complement the verification of numerical analyses and data processing. While verification provides review and confirmation of largely definitive work, peer review provides evaluations and assessment of interpretations, judgments, and decisions made.

Peer reviews shall be coordinated by the Project Manager. The reviews shall be performed by personnel not involved with the activities presented in the report, but who have technical expertise at least equivalent to those performing the work. Reviews should address the following, as appropriate:

- Were the work plans and procedures, as developed, sufficient to control and permit duplication of the project activities?
- Have procedures been correctly used?
- Did the procedures used result in obtaining data tives of the project and have the objectives been properly translated from applicable contractual requirements, industry standards, and federal/state/local regulations?
- Has sufficient data of adequate quality been collected to reach conclusions which can be justified and verified?
- Are assumptions, interpretations, judgments, or decisions supported by the data and are they defendable?
- What is the effect of variations upon results?
- Is documentation sufficient to verify the validity and reproducibility of report results?

Peer reviews shall be documented. It is recommended that the peer review report include the following:

- Date(s) of review
- Participants
  - Reviewers
  - Project personnel
  - Any Quality Assurance personnel
- Activities reviewed including interpretations, decisions, and judgments
- Statement of agreement or disagreement with interpretations, decisions, and judgments; including the means for resolving disagreements

- Recommendations for changes, the extension of existing activities, or the establishment of additional studies
- If questions remain unresolved beyond the end of the review, the means for closing the questions.

Review reports shall be transmitted to project management and appropriate Quality Assurance personnel.

Review copies of all internally reviewed reports will be discarded immediately following inclusion of comments in the final or next edition of the report. Documentation of report reviews will be by the "Report Review Procedure" Approval for Issuance Checklist and by peer review reports. The report review documentation will be maintained in the project file.

9.4 SUBMITTAL

The Project Manager shall determine the client or agency requirements for report submittal, including the number of copies required and to whom the report copies should be transmitted. Reports shall be accompanied by a letter of transmittal which states the report title, the number of copies transmitted, and the IT personnel to contact regarding questions concerning the report. The transmittal letter shall be signed by the Operations Manager, Project Director, Project Manager, or designee.

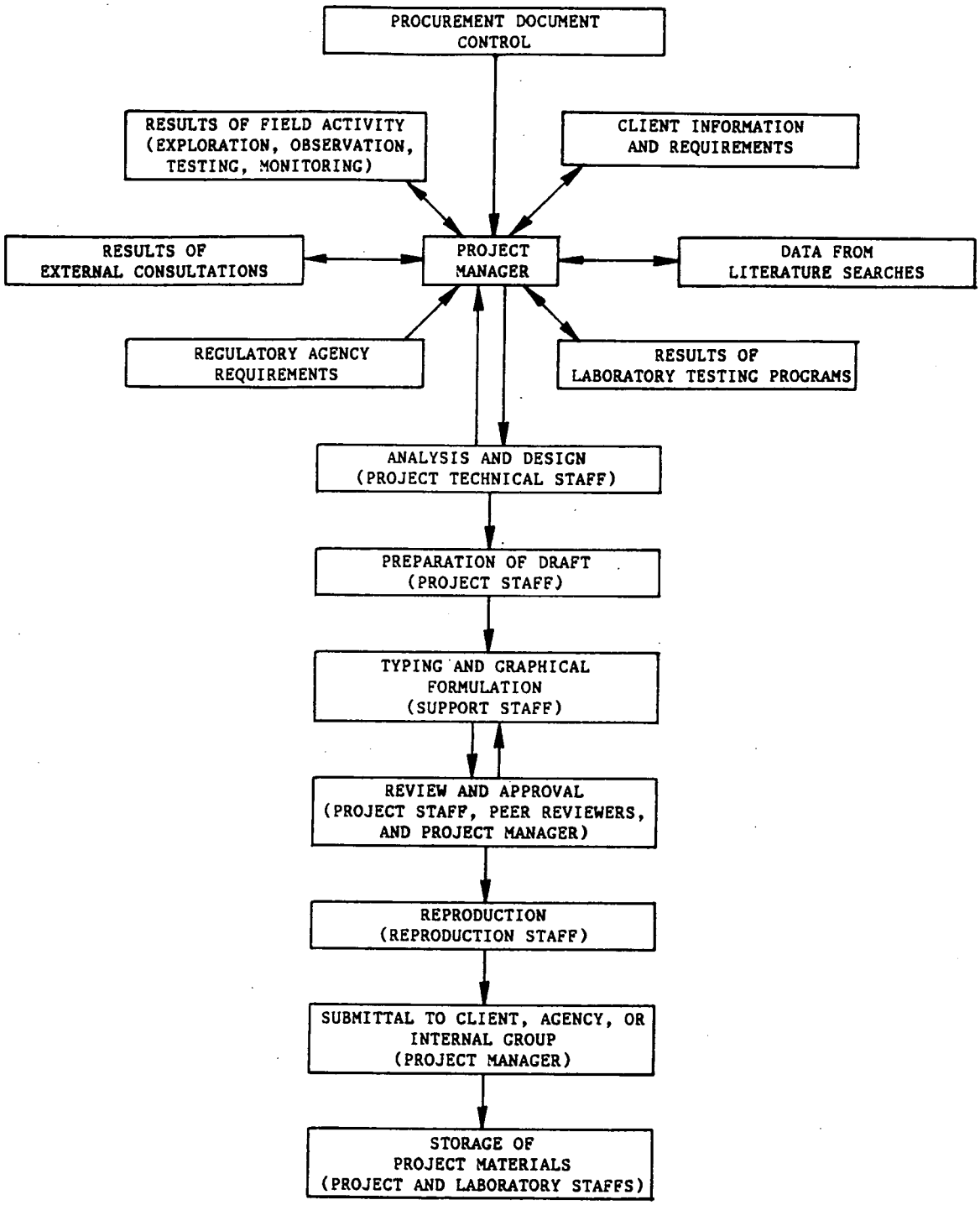

FIGURE 9-1

IT REPORT PREPARATION PROCESS

10.0 RECORDS MANAGEMENT

The IT Records Management System provides control and retention for project-related information. Record control includes receipt from external sources, transmittal, transfer to storage, and indication of record status. Retention includes receipt at storage areas, indexing and filing, storage and maintenance, and retrieval.

Filing systems and procedures adopted by IT are described in Sections 10.2 through 10.5. As necessary, project-specific controls may be developed in response to client requests. Project-specific controls can include the definition of external interfaces for information transmittal, required documentation and transmittals, personnel authorized to issue transmittals, transmittal frequency, and methods of record storage.

10.1 RECORD TYPES

Sufficient records shall be prepared during the performance of a project to furnish documentary evidence of the conduct and quality of the work. The records prepared for a specific project are dependent upon the contractual requirements and the scope of work for the project. Records may be originated by the client, subcontractors, and IT personnel. IT record preparation can involve personnel in Administration and Finance, the Project Group, Laboratories, Drafting, Health and Safety, Environmental Affairs, Computer Services, and Quality Assurance.

Records, or types of records, which may be prepared and retained by the Records Management System shall include, but not be limited to, those in Table 10-1.

10.2 RECORD FILING SYSTEMS

Records shall be controlled and retained, as appropriate, in office central files, laboratory files, on-site files, and the IT corporate permanent storage

files. The use of each system shall be based on the project scope of work and corporate, regulatory, and client record management requirements.

10.2.1 Office Central Files

Each IT office shall establish and maintain the following files as appropriate for the services provided by the office:

- Project central file
- Original drawing file
- Quality Assurance file (if not maintained in the central file)
- Generic computer program documentation and verification file.

The project central file shall be used for engineering operations related material except drawing originals, Quality Assurance records, general computer information, and laboratory records. Each of the office central files shall be maintained by designated support personnel in accordance with the requirements outlined in Sections 10.3 and 10.5.

10.2.2 Laboratory Files

Laboratory records shall be maintained in two broad categories:

- Documents which are specific to a project or group of samples within an ongoing project, such as chain-of-custody records and raw analytical data
- Documents which demonstrate overall laboratory operation, such as most calibration records, instrument logbooks, and control charts. These records will directly affect the data for a specific project, but in general their applicability is not limited to one project.

Laboratories shall establish and maintain files in accordance with the Quality Assurance requirements of Section 12.0 of the ITAS Quality Assurance Manual.

Both a project records file and a general laboratory operations records file shall be developed for each laboratory by individuals designated by the Laboratory Manager.

In general, IT laboratories will only submit the results of analysis to Project Groups. If the Project Groups require full documentation of the laboratory analysis, the Project Manager shall so notify the appropriate Laboratory Manager.

10.2.3 On-Site Files

Appropriate requirements from Sections 10.3 and 10.5 shall be used to establish and maintain records on site during a field investigation, sampling, or field testing program. A file, similar to the project central file (Section 10.2.1), shall be established and maintained by the field personnel under the direction of the Field Supervisor.

Upon completion of the field program or program phase, the on-site file shall be transferred to, and integrated with, the appropriate office central files.

10.2.4 Corporate Permanent Storage Files

Certain IT projects require "permanent" storage (e.g., for the life of a facility) of records to satisfy corporate, client, and/or regulatory requirements. These projects may include site characterizations and designs for nuclear waste repositories and chemical waste disposal facilities. Permanent storage shall follow the requirements of Section 10.5.3.

10.3 RECORD CONTROL

The control of records provides for the flow of information both internal and external to IT. Typical controls applied by IT for the various record systems are described in the following sections.

10.3.1 Receipt of Records

Project-related materials which are incoming to IT in the form of correspondence, drawings, sketches, logs, authorizations, or other information shall be routed to the Project Manager after the original is marked with the date received and the project number by a member of the Project Staff, or a secretary assigned this duty. The Manager shall then determine which personnel shall review the incoming materials and shall route the materials accordingly.

As soon as practical, correspondence originals shall be placed in the project central file. If the correspondence is required by IT personnel for reference, a copy should be made rather than holding the original. Correspondence which is addressed to the Project Group, but is of importance to the project Quality Assurance Program, shall be routed to appropriate Quality Assurance personnel.

Client drawings should be placed in the project central file when they are received. The file index shall indicate the date received, drawing number, and revision number. If revised issues of drawings pertinent to a project are received, superseded drawings shall be marked "void," "see revision _," or with a similar notation.

10.3.2 Transmittal of Records

Project-related materials transmitted external to IT including correspondence, reports, drawings, and sketches shall be appropriately reviewed, approved, and, as required, signed prior to transmittal.

Project correspondence shall, as a minimum, be signed by the Project Manager, Operations Manager, or an individual assigned this responsibility by the Project Manager. If joint signatures are desirable, the originator of the correspondence, when different than management, may also sign. Quality Assurance correspondence shall be signed by the Director, Quality Assurance

and Discipline Management, appropriate Regional Quality Assurance Manager or Quality Assurance Officer, or Lead Auditor.

Outgoing project correspondence and reports should be read, as appropriate, by the Project Manager prior to mailing. The office copy of project correspondence should bear routing information and be routed to Quality Assurance personnel, if judged appropriate by the Project Manager. As an alternative, individual copies of the correspondence may be sent, with the distribution indicated on the original. If, because of scheduling difficulties, it is necessary to mail correspondence prior to the Project Manager reading the final copy, the Project Director or the Operations Manager shall read the correspondence. A copy shall then be routed to the Project Manager.

Drawings issued in final form shall be approved prior to issuance by the Operations Manager, Project Director, Project Manager, or a member of the Project Staff delegated this responsibility by the Project Manager. Drawings which are issued preliminarily do not require approval prior to issue; however, they shall be clearly marked to indicate preliminary status. Drawings issued as a separate transmittal shall be accompanied by a transmittal letter listing each drawing by number. If a drawing is preliminary, it shall be stated in the letter. A copy of the drawings may be maintained by IT with the letter of transmittal, if deemed necessary by the Project Manager.

If an original drawing is transmitted to the client at their request, a good quality reproducible of that drawing shall be prepared prior to transmittal and filed in the IT original drawing file maintained by Drafting personnel. The transmittal letter shall explicitly state that the original drawing has been transmitted to the client.

10.3.3 Transfer of Records to Storage

Following receipt of information from external sources, completion of a field or laboratory phase of a project, completion and use of analyses and design

studies, and issuance of reports or other transmittals; associated records shall be submitted to the appropriate filing systems (Section 10.2). It is emphasized that records shall be legible and readily identifiable. In addition, field records and records being sent between IT offices shall be adequately protected from damage and loss during transfer (e.g., hand carrying or making copies prior to shipment). The transfer of records to the storage areas is the responsibility of Administration and Finance, Project, Laboratory, and Quality Assurance personnel, as appropriate.

Recognizing that Enginering Operations projects may not be confined to one location within IT, one office will be designated the lead office. The central file in the lead office will be the project records repository. All original project records will be transferred to the lead office central file at the end of the project or phase. The supporting offices may retain copies of the records in their central files. As with the transfer of all original documents, copies will be made of the original project documents before they are transferred to the lead office.

Field records and checkprints, initially maintained by the Field Supervisor (Section 10.2.3); laboratory data summaries; external laboratory test data; numerical calculations and checkprints; reports and other data transmittals; project-specific Health and Safety records; copies of proposals, bids, purchase orders for project services, and contracts; correspondence including incoming and outgoing letters, memorandums, telexes, and telephone records (on the standard IT telephone form); client drawings; photographs; and reference material shall be transferred to the project central file maintained by designated support personnel. Internal drawing checkprints requiring storage may be maintained in the project central file or stored by Drafting personnel in separate checkprint files. Documentation and verification of computer programs shall be submitted to the project central file (project-specific programs) and the computer areas (generic programs) for storage. Quality Assurance records (e.g., audit checklists and reports, Quality Assurance Project

Plans, and Quality Assurance manuals) shall be submitted to the Quality Assurance files. Records associated with laboratory operations and testing programs shall be transferred to the laboratory files (Sections 12.1 and 12.2 of the ITAD Quality Assurance Manual).

Records submitted to the project central file, with the exception of correspondence, should be bound, placed in folders or binders, or otherwise secured for filing. These records shall have a completed record maintenance form (Figure 10-1) attached to provide the necessary information for correct filing and prompt retrieval. It is the responsibility of the persons submitting the records, to complete this form. Folders or binders containing calculations and their checkprints shall be marked with the title of the calculations.

10.4 RECORD STATUS

To prevent the inadvertent use of obsolete or superseded project-related information, all members of the Project Staff are responsible for reporting such information to the Project Manager. In turn, the Project Manager, as appropriate, shall notify Project, Laboratory Staffs, and Quality Assurance personnel and other affected personnel of the resulting status change in project documents such as drawings, specifications, and procedures. The source of such documents may be IT, regulatory agencies, or clients. Notification of personnel of status changes in Quality Assurance procedures shall be the responsibility of the Director, Quality Assurance and Discipline Management, Regional Quality Assurance Manager, or Quality Assurance Officer as appropriate.

To purge outdated material from use, notification of personnel by the Project Manager should be in writing and should indicate the means for removal from use. In general, drawings and other documents shall be marked "void." However, the Project Manager may request the copies be destroyed. It is recommended that one copy of void documents be maintained for record purposes with

the reasons for and date of voiding clearly indicated. For expedience in informing field personnel of the status change in project documents, the Project Manager may personally communicate with them and indicate document changes which have occurred. Subsequent to this, the field personnel shall receive copies of the new documents.

To denote calculations, drawings, and other material which have not been formally checked, are based on information which has not been checked, or do not contribute to final project information; these documents shall be marked "preliminary" (Section 6.2).

10.5 RECORD RETENTION

Information related to a project shall be retained by IT. Procedures for retention in the various filing systems are outlined in the following sections. To accommodate various client requirements, IT will develop project-specific procedures if required.

10.5.1 Receiving of Records at a Storage Area

Project records shall be received at the various storage areas by designated support personnel. Designated personnel shall review incoming records to determine if they are properly identified for filing (e.g., records maintenance forms), are legible, and are in suitable condition for storage.

10.5.2 Indexing and Filing of Records

Indexing and filing of records shall be performed only by the designated storage area personnel.

Project files will be maintained by project number. In general, division codes and office designations will not be used to divide a project file. Different phases within a project can be used to separate the project file if this is deemed by the Project Manager as a means for providing clarity in the file system.

If several offices/groups are involved in the performance of a project, the lead office shall serve as the repository for the project. Other offices shall transfer their records to the lead office at appropriate times during the project, or at its conclusion.

For the project central file, individual file folders for each project shall be divided into appropriate categories based on content, and numbered and filed sequentially within each category (such as F-1, F-2, F-3). Folder tabs should be marked to indicate project number, project name, folder number, and file title (as it appears on the project index). Color-coded systems may also be used. Table 10-2 lists the various project central file categories, their respective letter designations, and examples of the contents for each category. All offices shall use the categories presented. If a specific project requires a different category, Category B can be used or a new category(s) added to the list.

A numbered index (Figure 10-2) for each project central file shall be prepared and continuously updated by designated support personnel. The index shall list the individual file folders and identify the records therein to facilitate locating the records. The index shall be kept in a separate folder at the front of each project file. If appropriate, information on project material not stored in the project central file should be included with the index. The project file shall only use the categories applicable to the project. Thus, for example, if field work has not been performed, there will not be an index Category E. However, the index shall have a separate index page for each applicable category.

Laboratory files shall be organized in a manner similar to the project central file. Material shall be maintained in accordance with laboratory Quality Assurance practices. (Sections 12.1 and 12.2 of the ITAS Quality Assurance Manual).

For the original drawing and Quality Assurance files, material shall be filed only by project number. Computer files of generic program documentation and verification shall be organized by program name. Drafting files are the responsibility of the Drafting Supervisor for an office/group. During the life of the project, Quality Assurance files should be maintained by the responsible Quality Assurance Officer. At the conclusion of a project, or when the file is transferred to "permanent" storage, the Quality Assurance file shall be merged with the project central files. Category Q (Table 10-2) shall be used for this purpose.

10.5.3 Storage and Maintenance of Records

IT utilizes storage facilities which provide a suitable environment to minimize deterioration, damage, and loss. The facilities shall, where possible, have controlled access and shall provide protection from excess moisture and temperature extremes. Records shall be secured in binders, placed in folders or envelopes, or otherwise secured for storage in containers (e.g., steel file cabinets).

For project central, laboratory, generic computer program documentation and verification, and on-site files, sign-out sheets shall be maintained by designated support personnel so that a record of files removed is available. A sign-out form shall include the project number, borrower's name, title or number of files removed, and the date signed out and in. When files are returned, they should be placed in an area designated for refiling. Support services personnel are responsible for signing in and refiling all material. If a file is needed for an extended period of time, a copy should be made.

As an alternate, drop-in oversize sign-out placards may be used. The placard will be inserted in the space occupied by the borrowed file folder. The sign-out placard will include the same information as the sign-out sheet: project number, borrower's name, title or number of files removed, and the date signed out and in.

Because of its bulk, large computer output will not be stored within the project central file, but should be kept in the central file area. The output shall be identified (Section 6.2.3) and indexed as calculations in the project central file index.

The length of storage for project-related material shall be based on regulatory and contractual requirements and IT policy. The determination of storage time for each project shall be made by the Project Manager and Quality Assurance personnel. Typical time periods for record maintenance following completion of a project will include:

- Records prepared as part of site mitigation (e.g., RI/FS) activities - 10 years
- Records associated with facilities governed by the Resource Conservation and Recovery Act (RCRA) - 5 years after closure, if the project was performed prior to closure; or for the 30-year monitoring period following closure, if the project was performed for the purpose of closure monitoring
- Records associated with nuclear projects (e.g., site characterization, geologic repository design, and repository seal design) - life of facility
- Conventional project records - 7 years.

If a specific contractual requirement, project demand, or government regulation requires that records be maintained for a longer period of time, the project files will be kept as required. For projects that must be kept beyond the normal retention periods stated above, the project index shall be marked to indicate the required retention period.

A records center(s) will be maintained by IT for the purpose of long-term records storage. The center(s) will be used by offices/groups for the storage of engineering records and by the laboratories for storing analysis records. This facility is in addition to the record filing systems for office central

files and laboratory files and shall satisfy the requirements of ANSI NQA-1, Supplement 17S-1, and/or duplicate records shall be stored in separate locations. Final storage in the IT corporate permanent storage files is the responsibility of designated support services personnel. Materials from the project central, laboratory, original drawings, and Quality Assurance files shall be stored with the exception of drawing checkprints for nonnuclear projects. Storage of nonnuclear drawing checkprints is the option of the Project Manager.

Single source final storage shall be in an IT-owned or contracted facility. Submittal shall be made at a convenient time following the active stage of the project. It is the responsibility of the Project, Laboratory, Drafting, and Quality Assurance personnel, to submit information associated with the project to the support personnel for storage. Support personnel shall prepare a final index list, including a listing of any project material that is not stored with the project file. This list shall be stored with the project file. Copies of the lists should be maintained for in-office use.

The designated support services personnel are responsible for obtaining and refiling materials signed out from single source final storage.

Duplicate record final storage should be obtained by microfilming project-related material and storing the microfilm and hard copy in separate locations. In some cases, machine copies of original records may be made instead of microfilming. Duplicate record storage locations may include any combination of the following:

- In-house IT storage in various company offices and storerooms
- IT permanent storage area
- Client facilities.

10.5.4 Retrieval of Records

Storage systems shall provide for the prompt retrieval of information for reference or use outside the storage areas. IT project records shall be accessible to the client, if so stipulated in the project contract, for the life of the records.

TABLE 10-1

EXAMPLES OF RECORDS TO BE CONTROLLED AND MAINTAINED

Bid Requests

Purchase Orders

Bids and Proposals

Contracts

Project Modifications from the Client

Applicable Codes and Standards

Licenses and Permits

Project Requirements and Specifications

Quality Assurance Program Manuals

Quality Assurance Project Plans

Project-Specific Work, Test, and Sampling Plans

Project-Specific Procedures and Review Copies

Project Quality Assurance Review Committee Modifications to the Quality Assurance Program or Project

Personnel Qualifications, Certifications, and Training Records

Health and Safety Records (training, personnel monitoring, air monitoring, accident reports, etc.)

Equipment Operations Manuals

Equipment Calibration/Maintenance Records

Laboratory Certifications and Results of Performance Evaluation Programs

Project Correspondence (letters, memorandums, telexes, telephone records, etc.)

Field Activity Logs

Field Investigation Data and Results (geologic field notebooks, instrument installation data, field collection forms, subsurface logs, test data sheets and tapes, sample custody forms, requests for analysis, inspection reports, etc.)

Photographs and Negatives

Field Activity Variances

Records of Laboratory Testing Program Development

12.0 MANAGEMENT PARTICIPATION

Fundamental to the success of any Quality Assurance Program is the active participation of management in the program. Management must be aware of program activities and must participate in development, review, and operation of the program. Active participation demonstrates the commitment of management to the Environmental Projects Group Engineering Operations Quality Assurance Program. This section outlines methods for providing the necessary involvement.

12.1 REPORTS TO MANAGEMENT

Management shall be informed of Engineering Operations Quality Assurance Program activities through the receipt, review, and/or approval of:

- Quality Assurance Manual and Manuals of Practice
- Project-specific Quality Assurance Project Plans
- Audit reports and audit closures
- Corrective action reviews
- Nonconformance reports
- Client problem/complaint log
- Monthly Quality Assurance Activities Report, including statistics.

The majority of the above documents are described in previous sections of this Manual. The Client Problem/Compliant Log and Monthly Quality Assurance Activities Report are discussed in Sections 12.1.1 and 12.1.2, respectively. In addition to the above formal documents, it is the responsibility of the Director, Quality Assurance and Discipline Management, the Regional Quality Assurance Manager, and the Quality Assurance Officers to informally keep group and office management informed of Quality Assurance Program operation.

12.1.1 Client Problem/Complaint Log

Project Managers and Engineering Operations Office Managers should maintain a Client Problem/Complaint Log. The log should include the name of the project and client, dates of log and communication of problem/complaint, nature of problem/complaint, proposed solution, if appropriate, and date problem/complaint resolved. The contents of the client problem/complaint log will be summarized monthly and submitted the Operations and Environmental Projects Group management. The purpose of the Client Problem/Complaint Log is two-fold. The log provides management with the status of problems while they can be readily resolved. The logs also provided overall feedback regarding IT operations. This feedback enables management to identify and correct problem areas within the Environmental Projects Group.

12.1.2 Monthly Quality Assurance Activities Report

Each Quality Assurance Officer shall submit a monthly Quality Assurance Report to the Director, Quality Assurance and Discipline Management. As an alternate, the Regional Quality Assurance Manager may submit a Regional Quality Assurance Activities Report for the region after receiving information from the offices in the region. If a Regional Quality Assurance Activities Report is submitted, the activities occurring in each office must be clearly identified.

The Quality Assurance Activities Report will aid the tracking of quality progress, provide the Director, Quality Assurance and Discipline Management with a report of activities, and provide information to the Operations Office Quality Assessment Committee.

The reports should include, as appropriate:

- Preparation or issuance of Quality Assurance Projects Plans
- Training sessions including content
- Results of Quality Assessment Committee meetings
- Actions taken to meet goals of Quality Improvement Plans
- Specific projects with quality problems and means of solution
- Audits conducted in office
- External audits of IT operations
- Effectiveness of office services such as drafting and central filing
- Suggestions for correcting and/or improving the Quality Assurance Programs
- Quality-related problems involving other IT groups.

12.2 MANAGEMENT REVIEW OF THE ENGINEERING OPERATIONS QUALITY ASSURANCE PROGRAM

Management review of the Engineering Operations Quality Assurance Program on a project basis shall be by participation of the responsible Operations Manager in the Project Quality Assurance Review Committee for that project. As a member of the Review Committee, this individual shall receive all audit reports and have access to Quality Assurance records.

In addition to the project-based review, a Quality Assessment Committee, which may also be called the Quality Improvement Committee, shall be established for each Engineering Operations office. This committee shall meet on a monthly basis. Members shall include the Operations Manager, Quality Assurance Officer, and a project-level individual from the office staff. The purpose of the Committee is to provide review and assessment of the Engineering

Operations Quality Assurance Program as it applies to the operation of each office. To accomplish this, the Committee should:

- Review the results of Quality Assurance audits conducted for projects assigned to the individual office or for projects which used personnel assigned to the office. These audits may have been performed by individuals both internal and external to IT. This review should be conducted at least twice a year, with the results providing an indication of how well the office personnel satisfy regulatory and IT Quality Assurance requirements.

- Perform an annual review of office operations. The review should, as appropriate, include office organization; procurement of subcontractors; development and use of office/group and project-specific procedures; identification and calibration of equipment; documentation of work activity results (i.e., field, laboratory, and office); and record maintenance. The review should evaluate office conformance to IT Quality Assurance requirements and to provide recommendations for improvement in work quality. This review shall be performed in the fourth calendar quarter of each year.

- Review quality trends of the office. This review should be performed annually in conjunction with, and using the results of, the reviews of audit results and office operations. It should identify the overall improvement or decline in office work quality and individual areas of strong performance or areas requiring additional emphasis and/or training. The review may be supplemented with audits requested by the Quality Assessment Committee and performed by Quality Assurance personnel for any project assigned to the office (e.g., Figure 4-1, bottom path). This review shall be performed in the fourth calendar quarter of each year.

Following completion of the yearly reviews of office operations and quality trends, the Quality Assessment Committee for each Engineering Operations office shall issue a Quality Assessment Report. This report should include the results of committee reviews and evaluations and any recommendations for deletions, changes, or additions to the Engineering Operations Quality Assurance Program. Reports should be sent to the Central Quality Assessment

Committee (subsequently discussed) and appropriate personnel in the reporting Committee's office prior to the end of the calendar year.

To serve as the focal point for office Quality Assessment Committee reporting and to provide Environmental Projects Group Management review of the overall Quality Assurance Program, a Central Quality Assessment Committee shall be established. Members of the central Committee include the Senior Vice President, Environmental Projects Group; Director, Quality Assurance and Discipline Management; and the Regional Operations Directors. The Committee shall conduct an annual review of the status and adequacy of the entire Engineering Operations Quality Assurance Program during the first quarter of the calendar year. The conduct, content, and date of the annual review shall be at the discretion of the committee; but the review shall include this Quality Assurance Manual and associated Manuals of Practice, the quality assessment reports issued by each office, preparation of new generic procedures, revisions to the Manuals, and the results of generic audits of IT offices (Section 10.1.2). The results of the annual review shall be documented.

TABLE 10-1
(Continued)

Laboratory Testing Data, Results, and Summaries

Laboratory Testing Variances

Sample Storage Inventories

Laboratory Quality Control Testing Data, Evaluations, and Control Charts

Results of Interlaboratory Testing Programs

Data Reductions, Numerical Analyses and Designs, and Associated Checkprints

Computer Program Input and Output

Computer Program Documentation and Verification

Drawings, Tables, and Associated Checkprints

Peer Review Reports by IT Personnel and Results of Reviews by External Organizations (including peer reviews)

Final Reports and Other External Data Transmittals

Quality Assurance Records (audit plans, checklists, audit reports, audit responses, corrective action overdue notices, audit closures, etc.)

Reference Materials (maps, papers, reports, newspaper articles, etc.)

Samples, if retained for archive purposes

TABLE 10-2

PROJECT CENTRAL FILE CATEGORIES

CATEGORY	LETTER DESIGNATION	CONTENT EXAMPLES
Correspondence	A	Incoming and outgoing letters, memos, telexes, telephone conversation records, etc. Subcategories will, as a minimum, include: "A1" - General in-house correspondence "A2" - Outgoing correspondence "A3" - Incoming correspondence
"Blank"	B	This category may be used for a project-specific need.
Originals	C	Typed originals for reports, regulatory submittals, applications, specifications, proposals, etc. Oversize tables should be folded and placed in the same folder as the report after the report has been printed. Camera-reduced copies of oversize tables should be included in the body of the report originals.
Bids, Contracts, and Specifications	D	Copies of bids, proposals, contracts, purchase orders for services, and specifications; whether they are submitted by IT to a client or subcontractor, or vice versa.
Field Data and Field Data Checkprints	E	Subsurface logs, test data forms, calibration records, daily field logs, sample collection forms, waste handling data, waste manifests, inspection reports, instrument installation data, subcontractor data, etc. This includes information generated by the field personnel at the site, with the exception of health and safety records.

TABLE 10-2
(Continued)

Calculations and Calculation Checkprints	F	Calculations and checkprints. Each set of calculations and checkprints should be placed in the same folder, if possible.
Reports From Others	G	Reports received from clients or reports by other organizations.
IT Reports	H	Copies of IT prepared reports containing the results of project activities and prepared by IT, except submittals filed in "L."
Photographs	I	Each photograph is to be identified by project number, date taken, and description. Photographs should be accompanied by their negatives.
Miscellaneous	J	Only for those extreme instances when an item cannot be placed in any other category.
Laboratory Data and Laboratory Data Checkprints	K	Laboratory test data and results for both field and office laboratories. In general, this will include only data prepared by laboratories external to IT. IT laboratories will maintain their data in the laboratory files. This catgory may be used for data summaries issued by IT and external laboratories.
Regulatory Submittals and Licensing and Permitting Applications	L	Copies of documents, including responses to questions, issued by IT to regulatory agencies either on behalf of a client or IT. Also included would be submittals made by a client using information provided by IT.
Reference Material	M	Reference materials such as client drawings, newspaper articles, journal articles, etc., which pertain to a particular project.

TABLE 10-2
(Continued)

Site Monitoring Records	N	Site monitoring records related to industrial hygiene such as personnel, area, and perimeter sampling and monitoring. These records should include only those not specified for maintenance with IT corporate health and safety records.
Drawing and Table Checkprints	O	Checkprints for drawings, figures, and sketches and transmitted tables.
Management Records	P	Management records related to the projects progress, including monthly job tracking reports.
Quality Records	Q	Project quality records including nonconformances, variances, audit reports and responses, and internal report review checklists.

IT CORPORATION

RECORD MAINTENANCE

PROJECT NUMBER: _____

PROJECT NAME: _____

SUBMITTED BY: _____

SUGGESTED FILE CATEGORY: _____

_____

TITLE OF FILE: _____

_____

_____

FIGURE 10-1

RECORD MAINTENANCE FORM

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FIGURE 10-2
PROJECT INDEX

PROJECT NUMBER: _____

PROJECT NAME: _____

CATEGORY: _____

FILE DESIGNATION	DESCRIPTION

11.0 QUALITY ASSURANCE AUDITS

To verify compliance with IT and project-specific Quality Assurance/Quality Control requirements, Quality Assurance personnel shall perform planned and documented audits of project-specific activities and nonspecific (generic) laboratory and office technical activities. These audits shall consist, as appropriate, of an evaluation of Quality Assurance/Quality Control procedures and the effectiveness of their implementation, an evaluation of work areas and activities, and a review of activity documentation. Audits shall be performed in accordance with written checklists by trained Quality Assurance personnel and, as appropriate, technical specialists. They shall be conducted to the level of detail necessary for the activity audited. Audit results shall be formally documented and sent to management of the activity audited for review.

Audits may be both scheduled and nonscheduled and can include, but not be limited to, the following areas:

- Subcontractor capabilities and performance
- Field operations and records
- Laboratory testing and records
- Equipment calibration and records
- Identification and control of samples
- Numerical analyses and designs
- Computer program documentation and verification
- Transmittal of information external to IT
- Record control and retention.

11.1 AUDIT TYPES

Two major categories of Quality Assurance audits will be performed: project-specific audits, generally performed by the Quality Assurance Officers assigned to IT offices, and generic audits of office and laboratory technical activities, performed by the Director, Quality Assurance and Discipline Management, the ITAS Quality Assurance Manager, the Regional Quality Assurance Manager, or members of the Environmental Projects Quality Assurance Group.

11.1.1 Project-Specific Audits

Several different types of project-specific audits may be conducted based on the needs of a project. The audits may be performed on IT activities (internal) or subcontractors to IT (external). Types of audits include:

- Field operations (internal)
- In-process project and report (internal)
- Project file (internal)
- Prequalification of subcontractors (external)
- Source (subcontractor) activities (external).

As indicated above, project-specific audits shall generally be conducted by the Quality Assurance Officers. Members of the Environmental Projects Quality Assurance Group and/or the Regional Quality Assurance Manager, however, may also perform or assist in the auditing. The determination of whether a project will require specific audits shall be based on the definition of project quality level (Section 4.2) and the scope of work. Project-specific audits shall be conducted in accordance with the requirements of Sections 11.2 through 11.4.

11.1.1.1 Field Operations Audits

A field operations audit involves an on-site visit by Quality Assurance personnel. Consultants, who are technically competent in the operations to be audited and independent of the subject project, may also participate as part of the audit team for the purpose of providing technical expertise. Items to be examined may, as appropriate, include the availability and implementation of approved work procedures, sampling, protocols, and specifications; calibration and operation of equipment; labeling, packaging, storage, and shipping of samples; performance documentation and checking; subcontractor performance; and nonconformance documentation. At the request of the auditors, subcontractor calibration records and personal resumes shall be furnished.

The scheduling of field operations audits will depend upon the Project Manager notifying Quality Assurance personnel that a field operation is to commence. It is preferable that the Quality Assurance personnel be notified prior to beginning work so the initial field audit can be scheduled in the early stages of on-site activity. The scheduling of the audit should be such that the resolution of corrective action will not adversely affect the project schedule nor impact a significant portion of the field work. The field operations audit schedule will be dependent upon the extent and complexity of the field operations. At least one audit should be conducted, with succeeding audits at least every six months. This frequency may be adjusted by the Director, Quality Assurance and Discipline Management or the Regional Quality Assurance Manager, as appropriate.

11.1.1.2 In-Process Project and Report Audits

Both in-process project and report audits consist of a review of pertinent project material. In process audits are performed during the course of work and usually concentrate on one specific task, such as design. Report audits consider all work performed that is to be reported. For a report audit, items examined may, as appropriate, include the documentation and verification of field and laboratory data and results; performance, documentation, and verification of analyses and designs; documentation and verification of computer programs; preparation and verification of drawings, logs, and tables; content, consistency, and conclusions of the transmittal or report; compliance with IT, regulatory, and client project requirements; and maintenance and filing of project records.

The records of field operations shall be reviewed to verify that field-related activities were performed in accordance with appropriate project procedures. Items reviewed shall include, but not be limited to, the calibration records of field equipment; field activity logs; photographs; and data, sample collection and custody forms, waste inventories, logs, and checkprints resulting from the field operations.

The auditing of laboratory results shall include, but not be limited to, the originals and checking of laboratory data sheets and Quality Control testing, originals and checkprints of data presentations prepared by the Laboratory Staff, laboratory test scheduling records for the project, and test equipment lists.

Auditing of analyses and designs shall include a complete review of calculations, computer input, sketches, charts, tables, and their associated checkprints that were prepared by the Project Group. These items shall be reviewed to verify conformance to project requirements.

The report preparation process shall be audited to verify that:

- The report correctly and accurately presents the results obtained by the project work
- Information presented in the report is substantiated by project work
- Tables and figures presented in the report are prepared and checked according to IT requirements
- The report satisfies the scope of work, IT and client requirements, and any pertinent regulatory requirements.

If peer review is undertaken for a report, the audit and peer review will jointly review these items. The audit shall also, as appropriate, review the maintenance and control of project documents to verify that applicable procedures have been implemented.

Report audits shall be performed prior to issuance of the final transmittal or report. The issuance of a final report shall be postponed if Quality Assurance personnel determine that the work does not meet requirements. If the project schedule demands issuance of a transmittal or report prior to audit, it may be issued "preliminary" or "draft," or the client may be formally notified that an internal audit is in progress and that the submittal will be

considered final only after completion of the audit process. The burden of scheduling the time needed for Quality Assurance personnel to perform a report audit rests with the Project Group. The Project Group shall notify Quality Assurance personnel sufficiently in advance to allow the audit to be performed and requests for corrective action satisfied.

11.1.1.3 Project File Audits

In general, the maintenance and control of project records shall be reviewed as part of in-process project or report audits. However, for individual projects having long periods of inactivity (greater than six months) or at the request of clients, the various areas designated for record storage may be separately audited.

The primary concern of a file audit is that project material, such as correspondence, memorandums, telexes, field and laboratory data, computer output, calculations, drawings, checkprints, and reports, is properly maintained in the record filing systems. Records shall be identified and maintained in a controlled manner that will provide their retrievability throughout the course of, and after, the project.

11.1.1.4 Prequalification Audits

If required by project requirements, Quality Assurance personnel shall perform a prequalification audit of potential subcontractors prior to bid award or the beginning of work. The purpose of these audits will be to determine if subcontractors are qualified to perform the desired work. Items to be covered may, as appropriate, include the qualifications of personnel, condition and calibration of equipment, documentation procedures, and the subcontractor's Quality Assurance/Quality Control Program. During the course of the prequalification audit, any instrumentation that is to be supplied by the subcontractor shall be inspected and approved for use.

11.1.1.5 Source Audits

To verify subcontractor conformance to procurement requirements, source audits shall be conducted, as appropriate, during the course of a project. Items reviewed may include the effectiveness of the subcontractor's Quality Assurance/Quality Control Program, implementation of work procedures, calibration and operation of equipment, performance documentation and checking, qualifications of personnel, and maintenance of records.

11.1.2 Generic Audits

Nonproject-specific (generic) audits shall be performed by the Corporate Director, Quality Assurance and Discipline Management, members of the Quality Assurance Group, the ITAS Quality Assurance Manager, and, as appropriate, the Regional Quality Assurance Manager or the Quality Assurance Officers, to provide an overview of implementation of the IT Quality Assurance Program in the various laboratories and offices.

11.1.2.1 Laboratory Audits

Laboratory audits will be conducted by the Director, Quality Assurance and Discipline Management and the ITAS Quality Assurance Manager. The primary responsibility for these audits rests with the ITAS Quality Assurance Manager. These audits will usually be generic, rather than project specific. Each laboratory (analytical or geotechnical) shall be formally audited once every six months. Audits of the analytical laboratories shall follow the requirements of the ITAS Quality Assurance Manual. Items examined by the audit team may, as appropriate, include the availability and implementation of approved laboratory procedures, equipment calibration and records, control and storage of samples, Quality Control sample program, performance documentation and checking, and nonconformance documentation.

During the course of the semiannual audits, the audit team should be cognizant of recurring nonconformances in laboratory operation or trends which will affect quality. Recurring nonconformances and trends should be addressed in

the audit report. Correction of such items may require a review of the adequacy of the laboratory Quality Assurance Program.

11.1.2.2 Office Operations Audits

Each office providing engineering services shall be audited annually by the Environmental Projects Quality Assurance Group. Primary responsibility rests with the Director, Quality Assurance and Discipline Management for performance of the audits. Audits of office operation shall follow the requirements of Sections 11.2 through 11.4 of this Manual. Items examined may, as appropriate, include the availability and implementation of approved work procedures, performance documentation and checking, control and retention of records, and activities of the Quality Assurance Officer.

At the beginning of each audit, the audit team shall meet with the Operations Manager, or designee, to discuss the scope of the audit. The Quality Assurance Officer and the Regional Quality Assurance Manager, of appropriate, should be available to the audit team throughout the audit. Following audit completion, the team shall meet with the Operations Manager to discuss the results and the means for satisfying any required corrective action. The Operations Manager is responsible for responding to the audit report.

11.2 AUDIT PROCEDURE

Auditing shall be initiated and conducted, as appropriate, in accordance with the following procedure.

An individual audit plan (e.g., Figure 11-1) shall be developed by the appropriate Quality Assurance personnel to provide a basis for each audit. This plan shall identify the audit scope, activities to be audited, audit personnel, external organizations to be notified, any applicable documents, and schedule. The plan shall be consistent with the project or audit scope, schedule, and requirements.

The audit team shall be selected based on the activities to be audited and the level of activity technology and complexity. Member selection shall consider technical expertise and experience in auditing. Most audits will be performed using only Quality Assurance personnel; however, technical specialists may also be used as necessary. All auditors shall be independent of the activities audited.

A Lead Auditor*, approved by the Director, Quality Assurance and Discipline Management, shall serve as team leader. Lead Auditor responsibilities shall include the selection and preparation of the team, coordinating the audit process, communications with the group or organization being audited, participation in the audit, coordinating the preparation and issuance of audit reports, and evaluating audit responses.

Checklists shall be prepared by the audit team and used to conduct all audits. They shall be developed so that necessary items are reviewed and to document the results of the audit. An example of an audit checklist is presented in Figure 11-2.

IT groups or external organizations shall be notified of a scheduled audit prior to performance. For external organizations, notification should be in writing.

Each audit shall cover the items necessary to verify proper control of the activities reviewed. During an audit and upon its completion, the audit team will discuss the findings with the group or organization audited and specify corrective actions to be initiated. Minor administrative findings which can be resolved to the satisfaction of the audit team during the audit are not required to be documented as items requiring corrective actions. All findings

*For nuclear projects, Lead Auditors shall be certified in accordance with the requirements of ANSI NQA-1, Supplement 2S-3, and Appendix 2A-3 (Section 4.3.3).

that are not resolved during the course of the audit and all findings affecting quality, regardless of when they are resolved, shall be noted on the audit checklists.

11.3 AUDIT REPORTS AND RESPONSES

After completion of an audit, the audit team shall prepare and submit an audit report to the following individuals:

- For project-specific audits the Project Quality Assurance Review Committee (Section 2.1)
- For generic laboratory audits, the Vice President Analytical Division, Laboratory Manager, Director of Quality Assurance and Discipline Management (if other than the Lead Auditor), ITAS Qualty Assurance Manager (if other than the Lead Auditor), and Quality Control Coordinator
- For generic office operations audits, the Senior Vice President Environmental Projects Group; appropriate Regional Vice President or Director; Operations Manager; Director, Quality Assurance and Discipline Management (if other than the Lead Auditor), Regional Quality Assurance Manager and appropriate Quality Assurance Officer.

If applicable, appropriate management of any external organization audited shall also receive a copy of the audit report. This report shall serve to notify management of audit results. The report may also be sent to individuals contacted during the audit and the members of the audit team.

The audit report shall be prepared as soon as possible (maximum 30 days) after the audit and contain, as appropriate:

- Date(s) and location of the audit
- Identification of audit participants
- Identification of activities audited
- Audit results

- Description of items requiring corrective action and, if possible, the means for correction
- Due date for completion of corrective actions and/or audit response
- Means for audit response (in writing).

Audit results shall include findings and observations. Findings are items which require corrective action. Observations are nonrequired recommendations made by the audit team to the group audited. Such recommendations are intended to improve project quality.

The report shall be signed, as a minimum, by the Lead Auditor. Checklists need not be included with the audit report.

If corrective action is requested in the audit report, the corrective action shall be undertaken and completed on schedule unless sufficient evidence can be provided to demonstrate that action is unnecessary. If required, the Director, Quality Assurance and Discipline Manager is empowered to stop work on a project pending resolution.

The group or organization audited shall respond in writing to the audit report. The response shall clearly state the corrective action taken or planned. It shall, as a minimum, be sent to the Director, Quality Assurance and Discipline Management, Lead Auditor and the responsible Quality Assurance Officer. If all corrective actions have not been completed prior to issuance of the audit response, a scheduled date for completion should be provided. It is noted that requests for corrective action must be addressed to the satisfaction of the Director, Quality Assurance and Discipline Management.

If the required response is not received by the due date set in the audit report, corrective action overdue notices may be sent by Quality Assurance

personnel to the same individuals receiving the audit report and, if applicable, appropriate management of any external organization involved. If for any reason the corrective action should still remain unresolved, the Director, Quality Assurance and Discipline Management is empowered to issue a "stop work" order to a project or subcontractor

Completion of corrective action shall be verified by the audit team through written communication, reaudit, or other appropriate means.

11.4 AUDIT CLOSURE

After acceptance and verification of all corrective actions, an audit closure shall be issued by the audit team to the same individuals receiving the audit report. It is emphasized that all audits must be brought to a satisfactory closure.

INTERNATIONAL TECHNOLOGY CORPORATION

3226 QUALITY ASSURANCE AUDIT PLAN

PROJECT NAME	DEVELOPED BY
PROJECT NO.	DATE

AUDIT TITLE

AUDIT LOCATION	AUDIT SCHEDULE	CHECKLISTS TO BE USED
	FROM _____	GENERIC • • • • • ☐
	TO _____	AUDIT SPECIFIC • • ☐

AUDIT PERSONNEL

LEAD AUDITOR _____
QA STAFF _____
TECHNICAL SPECIALISTS _____

GROUP OR ORGANIZATION TO BE AUDITED

IT GROUP _____
SUBCONTRACTOR _____
OTHER EXTERNAL ORGANIZATION _____

AUDIT TYPE

PREQUALIFICATION • • • • • • • • ☐
FIELD OPERATIONS • • • • • • • • ☐
LABORATORY • • • • • • • • • • ☐
IN-PROCESS PROJECT • • • • • • • ☐
PROJECT AND REPORT • • • • • • • ☐
PROJECT FILE • • • • • • • • • • ☐
SOURCE • • • • • • • • • • • • ☐
OTHER • • • • • • • • • • • • ☐

APPLICABLE DOCUMENTS

IT QA MANUALS • • • • • • • • • • ☐
PROJECT QA PLAN • • • • • • • • • ☐
CONTRACT/PROCUREMENT DOCUMENT • ☐
SPECIFIC/GENERIC PROCEDURES • • • ☐

ACTIVITIES AND MATERIALS TO BE AUDITED

SUBCONTRACTOR CAPABILITIES • • • • • ☐
QA/QC PROGRAMS • • • • • • • • • • ☐
FIELD ACTIVITIES & IN-PROCESS RECORDS • • ☐
IDENTIFICATION & CONTROL OF SAMPLES • • ☐
LABORATORY ACTIVITIES & IN-PROCESS RECORDS • ☐
EQUIPMENT CALIBRATION & RECORDS • • • ☐
PRODUCTION ACTIVITIES & IN-PROCESS RECORDS • ☐
IN-PROCESS NUMERICAL ANALYSES & DESIGN • ☐
COMPUTER PROGRAM VERIFICATION & RECORDS • ☐
COMPLETED RECORDS AND CHECKPRINTS:
- SUBCONTRACTOR • • • • • • • • • ☐
- FIELD • • • • • • • • • • • • ☐
- LABORATORY • • • • • • • • • • ☐
- NUMERICAL ANALYSES & DESIGN • • • • ☐

TRANSMITTAL OF INFORMATION TO IT • • ☐

TRANSMITTAL OF INFORMATION FROM IT:
DATA & RECORDS • • • ☐
COMPUTER ANALYSES • • ☐
SAR SECTIONS • • • • ☐
LICENSE/PERMIT APPLICATION • • • • ☐
RI/FS • • ☐
REPORT • • ☐
OTHER • • ☐
_____
_____

RECORD CONTROL & RETENTION • • • • ☐
OTHER • • • • • • • • • • • • ☐
_____
_____

FIGURE 11-1

IT CORPORATION

QUALITY ASSURANCE CHECKLIST

AUDIT

PROJECT NAME	PROJECT NO.	BY:	DATE	PAGE ____ OF ____

PARTICIPANTS	MATERIAL AUDITED	MATERIAL DESCRIPTION	FILE LOCATION
	LABORATORY TESTING AND RESULTS		

AUDIT QUESTIONS	YES	NO	N.A.	REMARKS / COMMENTS
1. HAVE PROPER IT DATA SHEETS BEEN USED?				
2. HAS ALL WORK BEEN PROPERLY HEADED (SIGNED, DATED, PROJECT NAME AND NUMBER, SAMPLE IDENTIFICATION)?				
3. HAS TEST EQUIPMENT USED BEEN UNIQUELY IDENTIFIED, CALIBRATED AND LISTED ON DATA SHEETS?				
4. HAVE ANY VARIANCES TO STANDARD TEST PROCEDURES BEEN DOCUMENTED?				
5. HAVE COMPUTER PROGRAMS USED BEEN VERIFIED? . . .				
6. HAS THE REDUCTION OF TEST DATA BEEN CHECKED? . .				
a. HAVE CHECKPRINTS BEEN MADE?				
b. HAS STANDARD CHECKING PROCESS BEEN USED? . . .				
c. HAVE CHECKPRINTS BEEN SIGNED & DATED BY CHECKER?				
d. HAVE ORIGINALS BEEN SCRUBBED?				
e. HAVE ORIGINALS BEEN SIGNED & DATED BY CHECKER?				
7. HAVE CURVES OR DATA SUMMARIES PRESENTING THE TEST RESULTS BEEN CHECKED?				
a. HAVE CHECKPRINTS BEEN MADE?				
b. HAS STANDARD CHECKING PROCESS BEEN USED? . . .				
c. HAVE CHECKPRINTS BEEN SIGNED & DATED BY CHECKER?				
d. HAVE ORIGINALS BEEN SCRUBBED?				
e. HAVE ORIGINALS BEEN SIGNED & DATED BY CHECKER?				
8. HAVE ALL FIGURES, TABLES, AND DATA SUMMARIES PRESENTING INFORMATION TRANSMITTED BY IT BEEN PROPERLY CHECKED?				

FIGURE 11-2

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