

DRAFT

QUALITY ASSURANCE ~~PROGRAM~~ PROGRAM PLAN

FOR

MULTI-TASK CONTRACT FOR REMEDIAL MEASURES AT UNCONTROLLED HAZARDOUS WASTE SITES

EPA Contract No. 68-03-3113

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TABLE OF CONTENTS

<u>Section</u>		<u>Pages</u>	<u>Revision</u>	<u>Date</u>
1.0	JRP's Ability to Implement a Quality Assurance Program			
2.0	Project Description			
3.0	Project Organization and Responsibilities			
4.0	Quality Assurance Objectives.			
5.0	Sampling Procedures			
6.0	Sample Custody.			
7.0	Calibration Procedures and Frequency			
8.0	Analytical Procedures			
9.0	Data Analysis, Validation and Reporting			
10.0	Internal Quality Control Checks and Frequency			
11.0	Performance and System Audits and Frequency			
12.0	Preventive Maintenance Procedures and Schedules			
13.0	Specific Procedures to be Used to Routinely Assess Data Precision, Accuracy and Completeness			
14.0	Corrective Action			
15.0	Quality Assurance Reports to Management			
	Appendix A Standard Operating Procedures			
	Appendix B Quality Assurance Project Officer Resume			
	Appendix C Bibliography			

1.0 JRB'S ABILITY TO IMPLEMENT A QUALITY ASSURANCE PROGRAM

JRB's Quality Assurance (QA) program ensures generation of measurement data of adequate quality to meet the specifications of the "Multi-Task Contract for Remedial Measures at Uncontrolled Hazardous Waste Sites". It also ensures the high quality of general project management responsibilities, including records and reports, facilities and equipment, performance and system audits, and corporate corrective action or follow-up.

JRB's QA program is designed to oversee the activities of JRB as well as our subcontractors and consultants. JRB recognizes the extreme importance of strict quality assurance for all work performed under this contract because of our past experience, and can tailor our QA program to meet the specific demands of all task areas.

The adherence to QA procedures for technical and enforcement support ensures that all data presented are as scientifically sound and statistically accurate as possible.

These qualities are essential for litigation and prosecution proceedings that may arise from the types of activities which will be conducted in this contract. Specific QA procedures related to activities such as sample collection, flow monitoring, laboratory analysis, engineering data reduction, and document control will ensure that data are fit for enforcement support. In addition, QA procedures for other project activities, such as employee credentials verification and company-wide compliance with DCAA accounting practice, etc., will ensure high quality and cost effective project management, products and services. Without a total QA program, work efforts performed would be of limited use and sometimes invalid.

1.2 JRB ORGANIZATION CHART

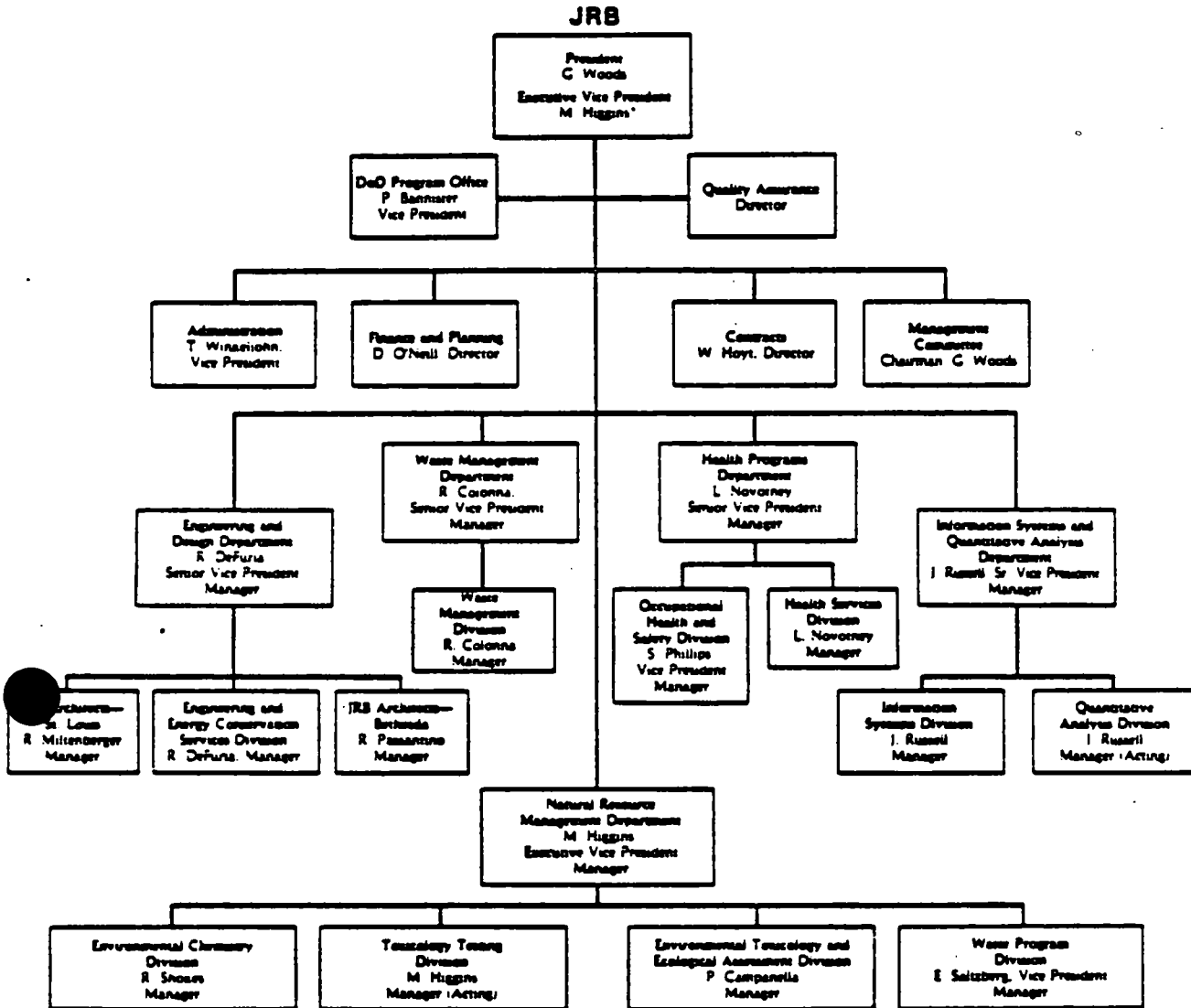
A JRB organizational chart is presented in Figure 1, and demonstrates direct reporting by the Quality Assurance Director to the President. It also displays the Quality Assurance Director's overall authority to interact with the other functional groups of the organization.

1.3 JRB CORPORATE QUALITY ASSURANCE POLICY STATEMENT

To reinforce the corporate commitment to excellence, a corporate-wide Quality Assurance Program (QAP) is being established. This program will supplement the traditional and continuing role of the project manager who carries the primary responsibility for quality assurance on individual projects. It will establish the President of the company as the corporate officer responsible for Quality Assurance at JRB.

The corporate QAP will be applied to every area of JRB's activities. It will cover especially those aspects of QA which extend beyond individual projects or are common among projects, such as the following:

- Fulfillment of every JRB commitment to quality, integrity, and propriety
- Identification, anticipation, and avoidance of potential risks
- Corrective actions
- Establishment of senior review for selected products
- Credibility and credentials of personnel
- Liaison with client organizations regarding overall QA policies and practices
- In-house staff training
- Authenticity of past project achievement descriptions
- Establishment of QA policies and procedures for all JRB activities.



*M. Higgins has authority to act for President and carries out special other management projects

FIGURE 1-1. JRB Organizational Chart

None of this will lessen the responsibility of each staff member for the quality of the work he or she produces, and for compliance with the standards required by professional ethics; nor will it lessen the current primary QA responsibility of the project manager. The function of the QAP will be to assist the JRB operational staff in complying with QA policy. The objectives of the program will be to ensure consistency and excellence of QA for all company activities, and to put into place corporate safeguards which will protect the corporate image and, by reflection, the professional reputation of the staff.

1.4 CORPORATE QUALITY ASSURANCE PROCEDURES

The Corporate Quality Assurance Program, as planned, relies on interactions among staff, department managers, the Quality Assurance Director (QAD), and the President to maintain its effectiveness. Department managers will inform the QAD of draft and final deliverables due over a given period. The QAD will review selected draft and final deliverables from each department for adherence to set quality standards. The QAD and the Department Manager will meet regularly and discuss the Department QA Update. The QAD will outline specific areas where the department has failed to meet the quality standards. The Department Manager and the QAD will then develop a strategy to rectify the problem, and the Department Manager will be responsible for implementing the strategy and correcting the problem by the next Department QA Update. If the problem is not rectified, or if progress has not been made towards rectifying the problem, then the QAD will discuss the situation with the JRB President and the Department Manager.

If the QAD uncovers a particular problem with a report, he will have the ability to hold up the report until the problem is addressed. In addition, if a department has received a particularly bad QA update, the QAD may request that all deliverables from that department be reviewed by the QA office before being released. Finally, performance and system audits will be performed regularly to determine whether proper lines of authority and communication are understood and followed, and to determine whether QA plans are being enforced.

A written report, prepared at the conclusion of each audit, will become a part of the official record for each contract.

This program will work because:

- The QAD is responsible to the President and not to the department managers.
- The QAD randomly samples deliverables so project personnel are not aware of which deliverables will be reviewed.
- The QAD and the department manager regularly discuss Department QA progress and develop strategies to correct deficiencies.
- The QAD can hold up reports if major QA problems are discovered.
- Primary responsibility for QA remains with project and department managers.

1.5 CORRECTIVE ACTION FOLLOW-UP PLAN

The Quality Assurance Director (QAD) will be empowered to take any corrective action necessary to preserve quality control of project activities. He will have the full support of the project manager and quality control representatives of our subcontractors. In the event that corrective action is needed and the project manager is unable to help resolve the situation, the QAD and the project manager will enlist the support of JRB's President.

One of the critical roles of a QA/QC program is the implementation of corrective actions in the event that a problem is encountered. During the lifetime of a project, many problems, both large and small, may be encountered. The QAD will document these problems in a formal report to be sent to the project manager, who has the primary responsibility for making the appropriate corrections. If the problem is discovered internally, he may simply correct

the problem within his staff or he may consult with the relevant parties to plan the proper course of action. If the problem is discovered by external audit, the project manager must consult with the QA staff prior to implementing corrective measures. All remedial procedures will be documented and, along with the initial report, will become a part of the permanent project file.

2.0 PROJECT DESCRIPTION

This project provides technical management services to the Environmental Protection Agency relative to research and development on remedial actions at uncontrolled hazardous waste sites. This work assignment contract includes tasks pertaining to information transfer, personnel safety, situation assessment and analytical support to develop concentration, separation and destruction techniques as applied to rapid-response remedial actions. The contract, managed by JRB Associates, will be performed on a task order basis by subcontractors and JRB itself.

Overall, this project spans the following technical applications:

- State-of-the-art reviews and assessments of technical literature and field practices, and evaluation of environmental economic impacts.
- Research, development and demonstration of technology involving instrumentation, detection methods and treatment devices. This also includes long-term permanent remedial actions at waste sites.
- Distribution of data, information and protocols in the form of reports, manuals, publications, presentation materials, presentations, films, exhibits, etc.
- Development of applicable regulations.

This Quality Assurance Program reflects, the necessary specifications to assure accuracy, precision, completeness, representativeness, and comparability on all tasks of this contract. The QA program described herein presents the general QA plan for this project, and includes tasks performed by the subcontractor; it will be the responsibility of the task managers and JRB QA/QC project officer to ensure that the proper level of QA is followed by all personnel involved in the contract. Should work assignments of an unforeseen topic be incorporated in this contract, the Quality Assurance Plan will be revised to reflect that change.

It will be necessary to prepare specific QA plans for those individual tasks which include research, monitoring and measurement activities which generate and process environmentally related data as part of the deliverables. It is important to note, however, that where several research tasks have essentially similar QA requirements, the same plan may cover all of them.

2.1 DEFINITIONS

For this plan, the following terms are defined:

- Data Quality: The totality of features and characteristics of data that bear on their ability to satisfy a given purpose. The characteristics of major importance are accuracy, precision, completeness, representativeness, and comparability.
- Quality Assurance (QA): An organization's total system of activities for assuring the reliability of the data it produces. This system integrates the quality planning, assessment, and improvement efforts of various groups in the organization to ensure that the requirements of the project are met.
- Quality Assurance Officer (QAO): The JRB staff member with overall responsibility for Quality Assurance for the contract activities. The QAO reports directly to the JRB Corporate President.
- Quality Assurance Program Plan: An orderly assembly of management policies, objectives, principles, and general procedures by which an organization outlines how it intends to produce quality data.
- Quality Assurance Project Plan: An orderly assembly of detailed and specific procedures by which an organization delineates how it produces quality data for a specific project or measurement method. An organization may have only one quality assurance program plan, but would have a quality assurance project plan for each of its projects.
- Quality Control (QC): The routine application of procedures for obtaining prescribed standards of performance in the monitoring and measurement process.

3.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

This section describes each JRB management function, both technical and Quality Assurance (QA), and describes how we plan to ensure the highest possible standard of quality at each level.

Project Manager

Mr. Robert A. Colonna, JRB's project manager, has overall responsibility for technical quality, cost control, project personnel management, and adherence to schedules. His overall management involves the quality assurance of the following items:

- Work Plans
- Deliverable Reports
- Subcontractor and Consultant Work Products
- Adherence to Delivery Schedules
- Cost Control and Cost Accounting on the Project
- Performance of Key Personnel on the Tasks

Mr. Colonna reports directly to Mr. Gregory Woods, President of JRB. The organization of this project is shown in Figure 3-1, on the following page. His primary interfaces at EPA are with the project officer and the contracts specialist.

Task Area Managers

Six task area managers have been assigned to cover the major task areas encompassed by this project. Tasks have not been assigned in all of these task areas as of this date. The task area manager is the first technical person involved when a work assignment is made. The task area manager,

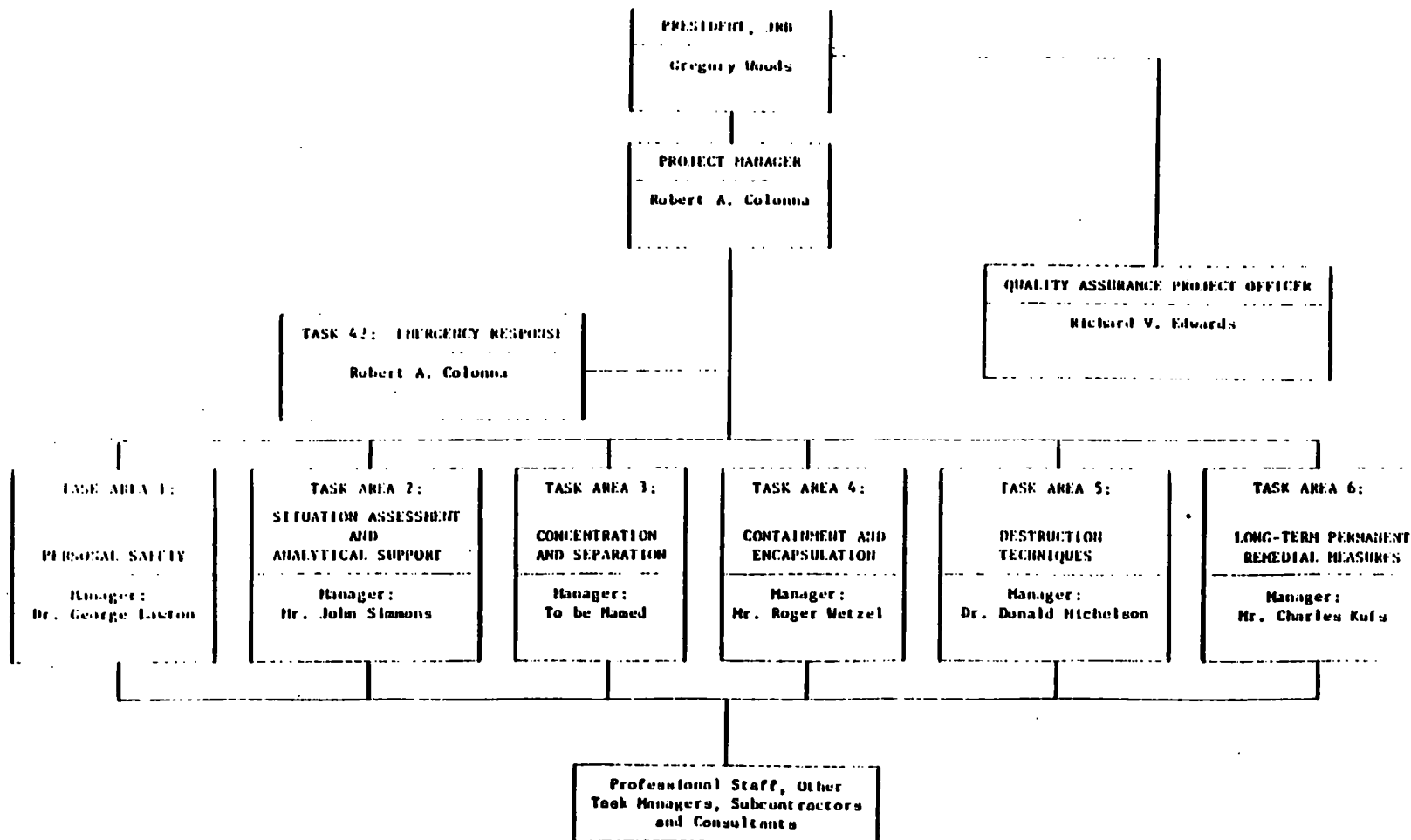


FIGURE J-1 Project Organization (Quality Assurance Reporting Relationships)

Section No. 3
Revision No. 1
Date 7/5/92
Page 2 of 5

012

along with the JRB project manager, and appropriate representatives from EPA (project officer, task officer), meet to discuss the strategy of work plan preparation. They then select a JRB task manager and assign him the responsibility for the task. The responsibilities of the task area manager include:

- Selection of task manager
- Selection of consultants (if necessary)
- Decision on whether to employ a subcontractor
- Supervision of task manager with respect to technical quality
- Preparation of work plans
- Review of work products

Task Managers

The task managers are responsible for technical performance on each task. They meet with EPA task officers during the work plan preparation and during the performance of the task. They also oversee consultants' and subcontractors' work. Their responsibilities include:

- Technical quality of work plan
- Technical quality of work on their task
- Technical quality of subcontractors' work products
- Adherence to QA procedures
- Adherence to delivery schedules

Their primary interface with EPA is the EPA task officers and staff. Task managers report to the appropriate JRB task area manager.

TMS-III QA/QC Officer

Mr. Richard Edwards has been assigned as the project QA/QC officer because of his technical, management and QA experience, and his familiarity with hazardous waste problems and issues. He has complete authority to enforce quality assurance procedures on this project. This includes all activities performed by JRB and any of our subcontractors or consultants. In the case where subcontractors have established their own quality control procedures and lines of authority, Mr. Edwards will retain oversight authority to ensure that all activities on this contract receive the requisite level of quality control. Mr. Edwards' resume is attached as an appendix to this plan. His responsibilities are:

- Management - The QAO will be responsible for ensuring that proper lines of communication are maintained during this project. He will routinely interview key staff to ascertain their knowledge and understanding of selected project issues. He will also work closely with the Task Leaders in the work assignment planning stage. He will maintain the resume and job description of each person responsible for the design, supervision, conduct or analysis of any study or test on this project for a period of three years following the performance of the activity.
- Technical Assessment - The QAO will be responsible for enforcing all quality control procedures for work assignment final reports and deliverables. For certain critical documents, the QAO will ensure that the formal sign-off procedures are followed and that proper records are retained for the official project file. In particular, he will:
 - Review each work plan for QA conformance and ensure appropriate revisions
 - Review a sample of work products on a quarterly basis
 - Review a sample of draft final task reports
 - Review laboratory and testing procedures on a quarterly basis

- Review a sample of each subcontractors' work products on a quarterly basis
- Review project cost accounting procedures quarterly
- Review delivery schedule compliance on a quarterly basis
- Report his findings on each of the above items to the EPA QA officer and to JRB's President on a quarterly basis
- Make corrections and updates to the QA/QC plan as needed
- Provide feedback to the JRB project manager on problems with quality so that corrective actions can be taken
- Training - The QAO will be responsible for determining staff training needs, and for ensuring that the proper training takes place to meet the training needs.
- Sampling and Laboratory Analysis - The QAO will require strict adherence by JRB's project team to establish monitoring and sampling procedures and laboratory protocols. The details of this aspect of our Quality Assurance Program are presented in JRB's sampling and analysis protocols. These protocols address such factors as monitoring and sampling controls; transport and storage of sampling; laboratory protocols; accuracy and precision checks; and data handling and verification procedures.
- Confidential Document Control - The QAO will monitor the activities of JRB's Document Control Officer to ensure that JRB's Security Plan is being enforced. The details of our plan include such factors as access to confidential business information, storage and retrieval of confidential documents, document control log, proper disposal of confidential information, and computer security procedures.

Plan Review, Approval and Distribution

Each specific QA Project Plan shall be approved by the JRB Project Manager, JRB QAO, the EPA Project Officer and other EPA personnel (such as the MERL QAO) as specified by the Agency. Environmental measurements will not be initiated until the specific QA Project Plan has received the necessary approvals.

A copy of the approved QA Project Plan shall be distributed by the Project Manager to each person who has a major responsibility for the quality of the measurement data. In addition, one copy of the approved plan must be placed in a permanent file by the QAO, Mr. Edwards.

For assigned tasks which involve the use of subcontractors, the QAO shall be responsible for seeing that the involvement of the subcontractors in environmental measurements are part of the specific QA Project Plan.

The QAO will work with the Project Manager and EPA Project Officer to resolve any QA problems which arise. He will submit a quarterly report to the EPA Project Officer and the JRB Project Manager. In general, the report will cover:

- Status of QA on project plans for the quarter
- Data quality assessments
- Significant QA problems
- Results of system and performance audits.

Facilities and Equipment

The requirements for all program facilities and equipment are determined by the kinds of measurements made in a particular task or project and the specific objectives (both technical and QA) of the program. Evaluation of task-specific facilities and equipment is the responsibility of the task area manager. Evaluation of facilities and equipment for the program as a whole are the responsibility of the Project Manager and QAO.

4.0 QUALITY ASSURANCE OBJECTIVES

Section 3.0 addressed management and broader QA/QC functions. This section focuses on technical QA/QC as it relates to data development and analysis.

The objectives for QA on the TMS-III contract are to have the highest level of QA that is both possible and feasible. Because of the possibilities of litigative support, the QA plan described here is targeted to be in accordance with MERL Level I standards. JRB's current analytic protocols encompass the QA procedures described herein and it is not expected that a task will be performed that reduces these procedures to a lower level of QA acceptability. While many of the TMS-III tasks will not require quantitative data collection, all tasks are expected to be conducted in an accurate, precise, reproducible, representative, complete and comparable manner. QA procedures will also be utilized for the tasks which are largely composed of literature reviews and information collection. This will ensure the credibility and reliability of the information gathered and incorporated into the project reports. Should the EPA project and task managers decide that a Level I QA effort is not necessary for a particular task, JRB will reduce the effort as directed.

When a work assignment is given to JRB, QA objectives for a particular task will be described in the work plan. To do so, a detailed experimental design for each task will be developed; once the technical considerations for the design have been developed, the QA objectives will be developed. These objectives will clearly state how accuracy, precision, representativeness, completeness and comparability will be determined during the performance of the task.

Specifically, these objectives are:

- The data should be accurate in terms of their agreement with reference or true values.
- The data should be precise in that there is agreement among individual measurements made under similar conditions.
- The data should be complete in terms of the amount of data available versus the amount of data evaluated.
- The data should be representative of the overall population or data base.
- The data should be comparable to other data for evaluation and testing purposes.
- The data should be reproducible under similar conditions, whether performed by same entity or another.

The quality assurance plan presented herein is intended to cover the major analytical parameters and situations that are currently anticipated on the TMS-III contract, at a minimum to cover the general analytical work. These procedures will be followed by all personnel on the project including subcontractors and consultants. If a work assignment includes functions that have not been previously addressed, JRB will prepare a QA/QC plan for the particular assignment. The task manager and QA project officer will prepare the QA/QC plan. All QA/QC plans will be submitted to the EPA project officer for his approval.

The TMS-III contract, as previously stated, covers a variety of technical subjects and activities from literature searches and data analysis to detailed experimentation and analytical work. Much of this manual is devoted to the analytical and sampling activities which will be performed on this contract. Section 5.0 is devoted specifically to the sampling of ambient air, water, sediments, soils, and waste materials at hazardous waste sites. Sampling other media such as stacks, biologic materials,

Section No. 4
Revision No. 1
Date 7/6/82
Page 3 of 3

etc., are not currently anticipated in the contract so were not included in the manual. If a need was developed to sample these medias, the QA manual would be revised as previously discussed. Section 3.0 is devoted to analytical procedures for the priority pollutants and other parameters.

5.0 SAMPLING PROCEDURES

Ultimate accuracy of any data generation activity begins with a sampling procedure which is well conceived and implemented. Prior to sample collection, a sampling plan with a clear purpose of analysis and methods to realize that purpose will be prepared. This will be preceded by proper sample container preparation, sample collection, preservation, and shipment requirements. Sampling procedures that are recognized as standard methods by EPA must be utilized when applicable. (See Appendix A: Standard Operating Procedures)

6.0 SAMPLE CUSTODY

A critical aspect of sound sampling and analysis protocols is the maintenance of strict chain-of-custody procedures. Chain-of-custody procedures include inventorying and record keeping during sample collection, shipment and laboratory processing. Proper record keeping is a must, and Level I QA/QC guidelines will be used to ensure the sample custody procedures are adequate to support any legal challenges, as was discussed in Section 4.0. The following specific information, at a minimum, will be entered in appropriate field logbooks; these notebooks will be official, bound logs in which data are recorded in ink and signed and dated with each entry.

- Sample number assigned
- Sampling location description to include source(s)
- Detailed description of sampling method including a list of the settings on any equipment used in the sampling process
- Date and time of sampling
- Name of individuals taking the sample
- Amount of sample collected
- QA/QC procedures followed at the site - such as taking sample blanks
- If a composite, frequency of sampling and volume of aliquots
- Flow information
- Observations
- Weather conditions
- Field measurement such as temperature and pH.

Each sample then will be uniquely and completely labeled immediately following collection. A seal is attached to each sample container in such a manner that the container cannot be opened without breaking the seal. This seal will list sample number, date and time of sample collection, and signature of the sampler; it is designed to assure that the sample is not tampered with during shipment. A sampling chain-of-custody form shown in Figure 6-1 will be prepared. Such a form will accompany the samples throughout the shipping and analytical process. The chain-of-custody form includes:

1. Unique field sample number
2. Date and time sample taken
3. Date and time sample submitted to the laboratory
4. Sample taken by (signature)
5. Information describing source of sample and its location
6. Sample matrix
7. Sampling method
8. Field chemist involved (signature)
9. Remarks (expected interferences, hazards, unusual events at sampling, etc.)
10. Preservatives added (if any)

If more information on any sample is necessary, the appropriate field notebook pages are referenced on the chain-of-custody forms under "Remarks".

Samples are maintained under proper holding conditions by the field chemist until custody is relinquished to the laboratory and formal documentation of such transfer is completed.

Upon receipt of samples in the laboratory, all samples are assigned a unique JRB log number (cross-coded with the Project's field numbering) and pertinent information is recorded in a bound log book. This log number applied to all analyses on the same sample and is recorded on the sample container(s) in waterproof ink. Samples are stored and analyzed in accordance with standard methods previously set out in the work plan.

The laboratory task manager directs work performance for each sample using Analysis Request Forms, as in Figure 6-2. Copies of these forms are given to the chemist performing the analyses. For certain projects involving multiple laboratories, instruments and analysts, a sample tracking form is used which accompanies each sample through the stages of analysis (example in Figure 6-3).

Each project or task is assigned a unique Project (or Task) File which includes the work statement, the approved work plan, the approved QA plan, all field documentation, analysis request forms, analytical results reports, and copies of QA/QC forms for permanent records. Raw data sheets are also included, as are cost tracking information and general correspondence and log books.

When samples are sent to another laboratory (split or otherwise) a sample shipment form is utilized (Figure 6-1). One copy of this form remains in the project file and another copy is sent with the transmitted samples.

After analyses are complete, samples are archived or disposed according to the requirements of the project or task, as stated in the contract or task work plan. Archived samples are so noted in the sample log book as to conditions and location.

Results are reported on standard laboratory forms unless a project or task specifies a tailored reporting format. Reports are signed by the analyst and the reviewer; originals are supplied to the task manager and copies are kept in the Task (or Project) File.

7.0 CALIBRATION PROCEDURES AND FREQUENCY

The following describes methods of performing calibration of the analytical instrumentation and field equipment, and the frequency of which each calibration type will be performed.

7.1 INSTRUMENT CALIBRATION

Step-by-step written calibration procedures are kept with each instrument. All calibration procedures are based on reference standards traceable to the NBS. Manufacturer's recommendations are followed when periodic calibration of an instrument is all that is required. To insure calibration on instruments with daily variances, three calibration samples at the low, middle and high ends of the working range are analyzed before any samples are run, and at the end of the instrument working day.

Gas Chromatograph/Mass Spectrometer Calibration

GC/MS system resolution and performance are evaluated and calibrated using decafluorotriphenylphosphine to satisfy the EPA specified criteria described by Eichelberger, Harris and Budde (1975). GC/MS system sensitivity is tested by 50 pg injections of DFTPP and TRFB for the electron impact ionization mode. Glass capillary GC/MS resolution is monitored using a capillary test mix of alcohols, ketones and n-alkanes.

Gas Chromatograph Calibration

Gas chromatographs (glass capillary column, EC, FID) are recalibrated daily or after every eight injections during 24 hour/day operation using a series of even and odd n-alkanes from n-C₁₁ through n-C₃₂. Retention times and response factors of each standard run are logged in a bound notebook kept at the instrument. Less than optimal instrument performance is remedied

at this point if necessary. In addition to retention time and response factor calibration of the instrument, linearity plots are run and recorded routinely to insure that analyses are being completed within the linear range of the instrument.

Electron capture gas chromatograph calibrations and linearity determinations similar to those described above are completed for chlorinated hydrocarbon and pesticide analyses. As with FID procedures, individual standards and mixtures of standards (such as PCB's) are injected to determine retention times and response factors for all compounds of interest, and values are recorded. Remedial action is instituted if necessary. Calibration procedures for the GC-equipped NPFID and FPD detectors are similarly enacted.

In addition to the calibration and quantitation procedures described above, daily checks on instrument parameters are also performed to insure that gas chromatographs and supporting hardware (i.e., septums, pneumatic systems, tape and disc drives, etc.) function properly. Hand calculations (checks) of software programs used in data reduction systems are performed on selected samples.

UV-Vis Spectrophotometer Calibration

The spectrophotometers are calibrated semi-annually with dilute potassium permanganate at dual peaks of 526 and 546. Readings are recorded in a bound log.

Atomic Absorption Optimization

In atomic absorption spectrophotometry (AAS), a number of variables must be held constant before the system is in statistical control. These variables include instrument warmup, burner alignment, gas flow, lamp intensity, slit width, wavelength, matrix effects, aspiration time and aspiration rate.

Procedure will include a minimum warm-up period of 30 minutes. The hollow cathode tube is aligned to produce the maximum emitted light to the detector. In flameless AAS, the inert gas flow inside the furnace is optimized to ensure maximum sensitivity.

For routine sample concentrations at levels greater than the highest standard of the analytical method, a secondary absorption line may be used in lieu of dilution, as specified by the Project Officer.

The digital readout values obtained for the standard curve of each element should fall within a specified range. If readings are excessively low, the operator should check gas flows, burner or cell alignment, wavelength, slit width, photomultiplier voltage and lamp intensity prior to analysis.

If large amounts of dissolved salts are present in the solution to be analyzed, the nebulizer will not handle the solution in the same manner as it will a solution with small quantities of dissolved salts. Such an interference should be accounted for by adding a salt to the standards or by matching the density of the samples and standards.

Burner heads, nebulizers, quartz cells and reduction flasks are cleaned according to manufacturer's instructions whenever excessive electronic noise is apparent or whenever indicated by visual inspection. Tygon tubing is replaced when deterioration is apparent. Optical lenses are cleaned on a periodic basis.

7.2 CONTROL SAMPLES AND CALIBRATION FREQUENCY

The Laboratory QA Monitor determines the lot size for each analysis and accordingly sets standards for the number and type of control samples to be analyzed with each lot. The QA Monitor will introduce control samples

(duplicates, spikes, and blanks) into the sample flow in an inconspicuous fashion. A random introduction of control samples will be accomplished during the logging process without leaving such clues as a sudden perturbation in the sequence of laboratory numbers or the appearance of a cleaned-up extract in a group of soil samples.

At least one standard (which may be an instrument calibration standard) and one control sample (whose working value has been established and run through the entire test procedure) will be included with each lot of field samples. When the control sample is not subject to the interference in the field samples, a previously run field sample will be included as a blind check sample. At least one natural water sample will be spiked at or near the detection limit and analyzed with each lot. A blank sample (one with no added amount of the constituent being determined) will also be run to aid in detecting reagent contamination and in solving those problems which occur near the lower limit of detection of the method.

. If the calibration frequency or methods are deemed by the EPA project or task officer as not being appropriate to a particular task, the QA/QC plan will be upgraded to include additional calibration procedures.

9.0 ANALYTICAL PROCEDURES

The following is a list of the analytical procedures typically used in quantitatively analyzing samples from hazardous waste disposal sites. If the task required or EPA requested a substitution of analytical procedures this would be done. If not, these methods listed below will be used.

Priority Pollutant Analysis

1. Organic Extractable Compounds
 - semivolatiles and pesticides - EPA Method 625
 - volatiles - EPA Method 624
2. Metals - EPA Method 600/4-79-020*
3. Cyanide and Phenols - EPA Method 600/4-79-020*

Conventional Pollutants - EPA Method 600/4-79-020*

1. BOD - EPA Method 405.1 Bioassay
2. COD - EPA Method 410.3 Titrimetric
3. TOC - EPA Method 4.5.1 Oxidation
4. pH - EPA Method 150.1 Electrometric
5. Oil and Grease - EPA Method 413.2 Spectrophotometric
6. Ammonia - EPA Method 350.3 Potentiometric
7. Nitrate - EPA Method 352.1 Colorimetric

TCDD - EPA Method 613

RCRA Ignitability - 40 CFR 261.21

RCRA Corrosivity - 40 CFR 261.22

RCRA Reactivity - 40 CFR 261.23

RCRA Extraction Procedure - 40 CFR 261.24

Herbicides: Methods for Benzidine, Chlorinated Organic Compounds, Pentachlorophenol, and Pesticides in Water and Wastewater, Sept. 1978.

*EPA Method 600/4-79-020: Methods for Chemical Analysis for Water and Wastes.

9.0 DATA ANALYSIS, VALIDATION, AND REPORTING

For each major measurement parameter a brief description will be given for:

- The data analysis scheme planned for collected data, including units and equations used to calculate values of measured parameters.
- Principle criteria to be used in validation of data integrity during collection and reporting
- Plans for treating outliers
- The data reporting scheme, including identification of key individuals who will handle data in this scheme
- Criteria to be used to validate non-analytical measurements such as literature reviews/surveys, i.e.; spotchecks of data being gathered, Senior Management Review, etc.

All data will be reviewed and approved by JRB's laboratory QA/QC Monitor prior to reporting. Standard Operating Procedures are included in Appendix A. Where SOP's are not specifically mentioned, EPA SOP's will be used.

10.0 INTERNAL QUALITY CONTROL CHECKS

In the analytical work plan, QC will be incorporated in the form of QA samples. This plan is reviewed by the QAO and EPA for approval before the task begins.

Field quality control includes the collection of all blanks; typically one blank per type parameter or media is necessary. Field blanks can include unused adsorbents, chemical solutions and unused filters. Field QA/QC samples include duplicate and/or field-spiked liquids or solids. In the laboratory, the general scheme of each analysis type includes a set of appropriate standards (generally 4), a method blank, and one duplicate and one spike at a level of approximately 15% of a typical sample concentration (including sample blanks). Reference material samples (SPMA) are analyzed periodically, at least once for each 10 batches. When spiking is not practical, the percentage of duplicates will be doubled or multiple spikes will be analyzed.

Spiked field and lab samples will be treated in the exact manner that the samples are handled. Analysis of split sample lots are often included. The exact scope of the QA/QC for any project will be determined dually by the laboratory task manager and the QA/QC project officer, with approval of the EPA and JRB project/task managers.

Detection Limit

Sufficient standards and blanks will be run to statistically establish the lowest measurable signal and the lowest concentration which may be distinguished from zero. The lowest calculated concentration will be reported as the detection limit of the method, provided that at least one of the spikes is below the calculated detection limit. The highest standard represents the upper limit of reportable data. For the purposes of calculating the detection limit, any non-linear portion at the upper concentration end of the calibration curve will be discarded.

This discarding process proceeds one point at a time in decreasing order of level of concentration. This practice of discarding data points one at a time results in a least squares line fitted to that segment of the data which may be modeled by a straight line (constant slope). The recommended process of one at a time deletion with successive comparisons of detection limits assures that the same minimum will be encountered by anyone using this method. Three or more data points must be used in the estimation of this regression line. Calculation of sample concentrations must utilize the same descriptive relationship as that employed in the calculation of the detection limit.

11.0 PERFORMANCE AND SYSTEM AUDITS

JRB recognizes the need for regular and unscheduled system and performance audits during the course of this contract. System audits will be performed every six months and will encompass all activities being conducted on this task. Unscheduled system and performance audits will be conducted once each six months or more often if determined necessary by the QAO. The following discusses specific details of each of these two audits.

System Audit

Once every six months, the project QA/QC officer and the corporate QA Director will conduct detailed systems audits across all active tasks on this contract. Specifically, record keeping practices will be reviewed, data analysis techniques evaluated and adherence to quality control procedures determined. The systems audit will also evaluate data management techniques and particularly quality control procedures where computerized data management techniques are employed. Reports which have been generated since the previous system audit will be randomly selected and data validation will be performed. At a minimum, this will include a spot check of references, verification of any calculations, data validation of raw to hard copy and an assessment of conclusions drawn from the analysis.

The results of the system audit will be reported to the EPA project officer, the JRB corporate QA Director and the project manager within two weeks following the completion of the audit.

Performance Audit

For each task which includes quantitative analysis as part of its work plan, performance audits will be conducted. The first audit will be performed just prior to the initiation of the analytical program. During this audit, the analytical techniques and the experimental design will be evaluated by the project officer and a peer of the responsible party who

will be performing the analysis (i.e., an experienced technologist who is not partaking in the analysis will assist in the performance audit). Particular emphasis of this audit will be placed on the QA/OC plan and methodology which have been written into the experimental design. Performance audits will also be conducted on sampling activities including at the point just prior to the initiation of the sampling activity.

At a minimum, a second performance audit will be conducted after systems are operational and are either generating or analyzing data. However, this audit will be attempted at the earliest possible point in the measurement program to minimize the effects if corrective action is warranted.

In sampling activities, the second performance audit will consist of observing the sampling procedure and the occasional taking of a field sample and blank which will be analyzed or evaluated immediately to detect if the sampling procedures are causing contamination. If field measurement equipment is being used, such as a pH meter, another meter will be brought to the site and simultaneous recordings will be taken.

For monitoring laboratory measurements, a sample will periodically be split and analyzed by another analyst on a different piece of equipment. This analysis will be performed blind; the QA/OC officer will make the comparison of results. Whenever possible, the performance audits will be performed in-house. In cases where only one instrument of a particular type exists, a determination will be made, along with the EPA project officer, as to how the performance audit will be performed. Two options exist: the split sample will be sent to another laboratory for analysis or the sample will be analyzed on a different day by a different analyst on the same piece of equipment or participates in EPA inter-calibration effort and/or EPA performance evaluation samples. Performance evaluation samples will be utilized whenever possible. These samples will either be provided by EPA or another government agency. Similarly, samples could be purchased from NBS for evaluation purposes.

All results of the performance audit will be kept on record and made available to the EPA project officer. Summary results of the performance audit will be sent to the EPA project officer every six months.

12.0 PREVENTATIVE MAINTENANCE PROCEDURES AND SCHEDULES

To obtain reliable data, equipment and facilities must perform properly at all times. Therefore, such equipment and facilities shall undergo regular inspection and preventative maintenance to guarantee that they are in good working order. A pre-arranged plan and schedule using accepted and documented procedures shall govern these activities. The specific QA Project Plan will give only the most important occasions or instances of required preventative maintenance. JRB's Standard Operating Procedures for preventative maintenance are included in Appendix A.

13.0 SPECIFIC PROCEDURES IN USE TO ROUTINELY ASSESS DATA
PRECISION, ACCURACY AND COMPLETENESS

The following describe the methods that will be used on the TMS-III contract to assess accuracy, precision and completeness of data being generated. The end of this section discusses how determination will be made on non-analytical tasks.

Accuracy

The accuracy of a method is expressed as the slope (b) of the least squares regression line of a plot of "measured" vs. "target" concentrations. The regression line is based on a minimum of three concentrations. Data are initially generated using standard samples, which provide the "best-case" value of the slope. Natural samples will be analyzed similarly, and these data will be added to the control chart. Values from sample sets will be added as they are generated.

Accuracy control charts will typically be generated as follows, unless otherwise directed by a project's requirements:

1. Seven standard samples are spiked at the levels of 1DL, 1ODL and 1OODL and analyzed.
2. The mean and standard deviation at each concentration level are calculated.
3. A plot of the "measured" vs. "target" concentrations is constructed. The least squares regression line of this plot is derived, and the mean and standard deviation of the slope are calculated.
4. The mean is the center line of the control chart. The standard deviation(s) of the slope (over several days) is the basis of the warning and control limits. Warning limits are placed at the mean $\pm 2s$, and control limits are the mean $\pm 3s$.

5. Data outside of the control limits is not valid and subject to QA review. Similarly, seven points on the same side of the central line constitute an errant situation, and QA review is needed. No data generated since the last valid control sample is submitted until the problem(s) is rectified.
6. With each sample lot, the slope is calculated and added to the control chart. The slope is then pooled with previous data to determine the values for control of the next sample set.

Precision

The measure used to estimate the precision of a method is the standard error of the estimates ($S_{y,x}$) for the least square regression line of "measured" vs. "target" concentrations. For example, data from standard waters are used first to determine the precision of the method, and then data from natural source water are used to determine the variability added by the source (and the sampling). Distinct precision data is generated for specific narrow concentration ranges.

The primary role of this application is to characterize the precision of any analysis method under specified conditions. This allows immediate comparison of precision of different methods of analysis and/or different results under the same method. Operating on data generated from standards water will produce only one estimate of $S_{y,x}$, which is retained for reference purposes. This precision estimate should always be smaller than that found for any natural system. Exceptions to this must be verified through a careful check of all calculations. Operations with natural samples will theoretically produce as many $S_{y,x}$ estimates as there are sample types. In establishing a methodological approach, these several values should be pooled (for a given narrow concentration range) in accordance with the following formula:

$$S_{y,x} = \left[\frac{\sum (y_i - \bar{y})^2 - b^2 (\sum x_i - \bar{x})^2}{n-2} \right]^{1/2}$$

where

n = number of replicates of each target concentration

N = number of target concentration.

This pooled estimate of the standard error is assumed to be the best estimate of the variability of the method. It is a single parameter estimate of the precision of the method and can be compared with similarly derived values. Future analyses should fall within these precision boundaries, and failure to do so flags the analyst, the task manager and the QA project officer.

Daily precision control charts will be used and constructed similarly to the accuracy charts. For any given concentration, the mean and standard deviation of the replicates will be calculated. The mean is the center line, and warning and control limits are $\pm 2s$ and $\pm 3s$, respectively. Data from each sample set will be pooled with previous data points to generate new control values for the next set.

The following additional laboratory QA/QC procedures will be used to assess accuracy and precision; these include linearity, recovery and use of standard additions.

Linearity

The measure of linearity between the spike level and the response signal is represented by the correlation coefficient (R_{xy}). Accuracy and precision test data should always reflect a positive value of R_{xy} equal to or greater than 0.90. The laboratory has found that virtually all standards addition data shows positive correlation measures in excess of +0.99. The slope of the regression line is expected to be +1.0 after suitable corrections for scale differentials between spike and signal levels. Experimental values will deviate from this expected value, in a random Gaussian. These deviations are assumed to be random Gaussian except when influenced by insolubility disturbances.

Recovery

The recovery of the method for the analysis of environmental samples is determined by adding a spike (T_1 , true value) of 50 ppb PCB to the sample selected earlier for replicate analysis. After the sample is analyzed and the observed value (D_1) is calculated, the recovery for the spike will be calculated as follows:

$$P_i = 100 (D_1 - X_1) / T_1$$

where P_i is the percent recovery. If the sample was diluted due to the addition of the spike, X_1 is adjusted accordingly. After determining P_i for at least 15 spike results, calculate the mean percent recovery (\bar{P}) and standard deviation (S_p) of the recovery as follows:

$$\bar{P} = \frac{\sum_{i=1}^n P_i}{n}$$
$$S_p = \sqrt{\frac{1}{n-1} \left[\sum_{i=1}^n P_i^2 - \frac{(\sum_{i=1}^n P_i)^2}{n} \right]}$$

where

n = number of percent recovery values available.

If the percent recovery of the spike is not within the interval of $\bar{P} \pm 3 S_p$, the system accuracy is out of control and the source of this systematic error must be identified and resolved before continuing with routine analysis.

At least one spiked sample will be analyzed along with each set of 20 samples or less that is analyzed at a given time. These spiked data are obtained for each parameter of interest. The recovery data of all spiked analyses are recorded and periodically (every 25 to 30 data points) the accuracy criterion are revised, updated, and improved.

Method of Standard Addition

When the results of an analysis by standard additions are plotted, any observed departures from the predicted slope (equal to 1) may be taken as estimates of inaccuracy. These inaccuracies are due to the inability of the system to generate data which are independent of interferences. The results of the seven samples will be averaged as an estimate of the inaccuracy of the method for such a population of samples.

Completeness

Completeness will be expressed as the percentage of the amount of valid data obtained compared to the amount of data expected. On the percent recovery required to ensure data accuracy, unless specified in the work plan, a minimum 90% completeness will be the goal for the contract. For non-analytical tasks, accuracy, precision and completeness will be assessed in a qualitative fashion. The following describes some ways in which these parameters could be determined.

- Accuracy: in determining accuracy in a data analysis task, the methodology used to perform the analysis will be evaluated for its ability to generate reliable and reproducible results. Data will be cross-checked and during systems audit will be traced to its origin to check the accuracy.
- Precision: if an analysis included developing a generalized model or developing scenarios as a means of performing a study, precision would be determined by comparing these outputs to a "known" situation. An example would be a technology assessment which included a set of conclusions from various data sources; these conclusions would be compared with a known test site and precision would be determined based on this comparison.
- Completeness will be determined by evaluating the sources studied versus the total universe of data available.

14.0 CORRECTIVE ACTION

The need for corrective action comes from several sources: equipment malfunction; failure of internal QA/QC checks; failure of performance or system audits; and noncompliance with QA requirements. Each task in the experimental design will define what the acceptable limits are beyond which corrective action must be implemented.

If measurement equipment or analytical methods fail QA/QC, the problem will immediately be brought to the attention of the task manager and project QA officer. If failure is due to equipment malfunction, the equipment will be repaired, precision and accuracy will be reassessed, and the analysis will be rerun.

If noncompliance is determined in the nonanalytical parts of the project, the cause of this noncompliance will be assessed and a determination made by the project QA officer as to how to rectify the problem. Corrective action in this case can take several forms. Work will be reanalyzed or repeated by the same or different entity or a new work plan will be developed which refocuses the manner in which the work will be performed. All work which will be performed as part of corrective action will be directly supervised by the JRE project officer and will be subjected to a rigorous evaluation by the quality assurance officer prior to submittal to EPA.

In both cases of noncompliance, all attempts will be made to reanalyze all affected parts of the analysis so that in the end, the product is not affected by failure of QA requirements.

All incidents of QA failure and the corrective action tasks will be reported immediately to the EPA project officer.

15.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

Each task final report and technical outputs will include a section or statement that discusses and evaluates data quality and validity. At a minimum, the following information will be covered in the progress reports and the final task report:

- Assessment of measurement data precision, accuracy, and completeness
- Documentation of QA/QC practices
- Performance audit results
- System audit results
- Significant QA problems and recommended solutions.

For the total TMS-III project, a report by the JRB QA Officer will be submitted quarterly to the EPA Project Officer and the JRB Project Manager covering in general:

- Status of this project plan
- Status on the coverage of specific QA project plans under this contract
- Data quality assessments
- Significant QA problems
- Results of system and performance audits.