RDI-XO-002

QUALITY ASSURANCE (QA) MANUAL
FOR WORK ON
QUALIFYING CLASS 1E EQUIPMENT FOR
NUCLEAR POWER GENERATION STATIONS

RESEARCH DYNAMICS INCORPORATED

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FOIA-84-863
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FEBRUARY, 1984

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INTRODUCTION

The specific purpose and intention of this Quality Assurance (QA) Manual is to set forth the quality assurance program of Research Dynamics Incorporated (RDI) as it relates to the testing activities of RDI on:

1. Qualifying Class 1E equipment for Nuclear Power Generation Stations as specified in IEEE Standards 323-1983, applicable daughter standards, and in 10CFR50.49, Code of Federal Regulations.

2. Conforming with 10CFR50, Appendix B, Code of Federal Regulations (included as Appendix I).

3. Conforming with 10CFR21, Code of Federal Regulations (included as Appendix II).

4. Conforming with Section 206, Energy Reorganization Act - 1974 (included as Appendix III).

Further, any significant variation that might occur in the procedures, plans, organization, etc. from that which is stated in this manual will be reported expeditiously to the client as a supplement to this manual.

Class 1E equipment is defined in IEEE Standard 323-1983 as follows:

"The safety classification of the electric equipment and systems that are essential to emergency reactor shutdown, containment isolation, reactor core cooling, and containment and reactor heat removal, or otherwise are essential in preventing significant release of radioactive material to the environment."

RDI is a profit-making research and development corporation, established in September, 1977 and incorporated under the laws of the State of Ohio. It is categorized as a small business firm. RDI's IRS number is 31-0916363. The legally-stated purpose of RDI is, "To engage in any lawful act or activity for which a corporation may be formed under Section 1601.01 to 1701.98, inclusive of the Ohio Revised Code."

The intended stated purposes of the organization are:

1. To work in cooperation with industry, government, and academic institutions to advance the knowledge of the physical sciences, and to provide services directly or indirectly aimed at the betterment of society.

2. To work in cooperation with the universities to provide financial support to faculty and students in return for services rendered.

3. To manufacture and/or market products of advanced technology.

4. To encourage and to promote inventions.

5. To foster the international development of science and technology.

6. To make profit above salaries, commissions, and expenses to enable growth in personnel and equipment, and to ensure financial stability to the corporation.

7. To enrich the lives of the employees of the corporation through the provision of the opportunity to exercise their professional skills.

8. To promote and encourage the dissemination of the knowledge gained and/or advanced by the employees of the corporation or by their associates, when in the best interest of the corporation.

Fitting in appropriately with the above-stated purposes is the purpose and organization by RDI of a testing program to qualify Class 1E equipment for use in nuclear power stations. RDI, as prime contractor on the project, provides the main thrust of the testing work and program direction with other firms, as subcontractors to RDI, providing support. The University of Cincinnati (UC) provides irradiation services, technical assistance with respect to these services, and laboratory support. Farwell & Hendricks, Inc. (F&H) provides facilities and support for seismic and vibration tests in accordance with IEEE Standard 344-1975. RDI's Quality Assurance (QA) Officer will monitor the work of these two subcontractors as well as that of all other subcontractors.

This QA Manual specifically addresses the following applicable criteria of 10CFR50, Appendix B:

Criterion I	Organization
Criterion II	Quality Assurance Program
Criterion IV	Procurement Document Control
Criterion V	Instructions, Procedures, and Drawings
Criterion VI	Document Control
Criterion VII	Control of Purchased Material, Equipment, and Services
Criterion VIII	Identification and Control of Materials, Parts, and Components
Criterion X	Inspection
Criterion XI	Test Control
Criterion XII	Control of Measuring and Test Equipment
Criterion XIII	Handling, Storage, and Shipping
Criterion XIV	Inspection, Test, and Operating Status
Criterion XV	Nonconforming Materials, Parts, or Components
Criterion XVI	Corrective Action
Criterion XVII	Quality Assurance Records
Criterion XVIII	Audits

Criteria III and IX are not considered applicable for the following reasons:

Criterion III, "Design Control"

The testing activities covered in this program do not include any new design or verifications of the existing design calculations relating to components to be used in a nuclear power plant. All testing results shall be documented in accordance with procedures listed in this manual and shall be submitted to the client for acceptance.

Criterion IX, "Control of Special Processes"

There are no special processes applicable to the scope of the testing activity in this program. All testing is performed to validate the design criteria of each system and components. Any nondestructive testing required to verify quality requirements would be performed by others.

I. ORGANIZATION

I. DISCUSSION OF PERSONNEL AND DUTIES IN ORGANIZATION OF THE RDI NUCLEAR REACTOR COMPONENT QUALIFICATION PROGRAM

An organization chart for this program is shown in Figure 1. All persons in the direct chain of project responsibility are employees of RDI. A description of the key personnel and their duties is given in the following paragraphs. Biographical sketches of these personnel are included as Appendix IV. All personnel involved in the testing program are qualified at the appropriate level according to ANSI/ASME N45.2.6-1978.

1. <u>Program Manager, Dr. James N. Anno</u>

   Dr. James N. Anno, President of RDI, assumes the ultimate full responsibility for the successful and compliant conduct of the program. He delegates to the Senior Test Engineer the execution of the testing program. Dr. Anno has had over 25 years of project management experience.

2. <u>Senior Test Engineer</u>

   The Senior Test Engineer is responsible for the execution of the testing program, including the preparation of test plans in accordance with IEEE Standard 323-1983. Directly responsible to him are the Senior Research Engineer, Assistant Project Engineers, and a Test Technician. He is supported by a QA Officer who reports independently to the Program Manager. He is also supported by the Purchasing Controller who reports independently to the Program Manager.

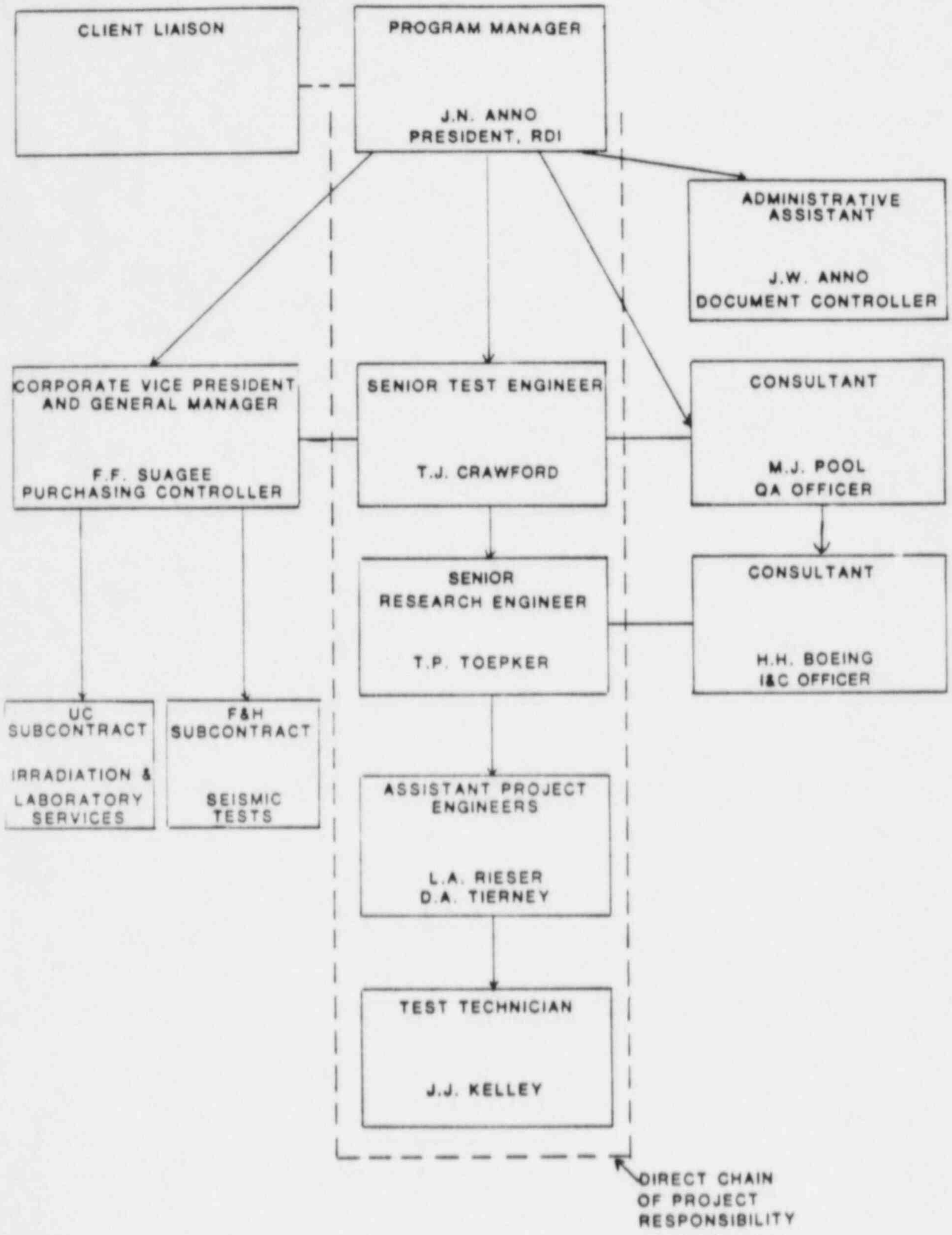

FIGURE 1. ORGANIZATION CHART FOR PROJECT OPERATION: RDI NUCLEAR REACTOR COMPONENT QUALIFICATION PROGRAM

3. Senior Research Engineer

The Senior Research Engineer serves as the direct assistant to the Senior Test Engineer. He assists the Senior Test Engineer in the writing and implementation of test plans, procedures, and final qualification test reports. He also works to procure the necessary testing that may be needed. He also works with the QA Officer in the revisions of the QA Manual. He is assisted by the I&C Officer who reports independently to the QA Officer. He also oversees the activities of the Assistant Project Engineers and Test Technician.

4. QA Officer

The duties of the QA Officer include, but are not restricted to, the review and approval of test plans and procedures, inspection, upon receipt, of QA instruments for testing, observance of all program testing activities, and conducting all appropriate audits. Included in his duties are the identification of quality problems, and the recommendation and implementation of solutions to such problems. He has the authority to stop all work or testing if he sees a procedure violation or nonconformity. He reports directly to the President of RDI as an independent and organizationally-free agent. He will monitor not only the quality of direct RDI testing, but that of all subcontractors.

5. Purchasing Controller, Corporate Vice President and General Manager

The Purchasing Controller is responsible for monitoring the purchase of all material, supplies, test equipment, and measuring equipment required on this

program, as determined by the Senior Test Engineer or Senior Research Engineer. As General Manager, he monitors and administers all subcontracts.

6. I&C Officer

The I&C Officer has the responsibility of ensuring that all test equipment requiring calibration is satisfactorily calibrated and maintained. The I&C Officer has the authority to delegate the calibration of test equipment to RDI personnel, who may delegate this to outside vendors. He directly assists the Senior Research Engineer, and reports independently to the QA Officer.

7. Document Controller

The Document Controller has the responsibility to control the issuance of documents, such as instructions, procedures, and drawings. The Document Controller also serves as Administrative Assistant to the Program Manager.

8. Assistant Project Engineer

The Assistant Project Engineer allocates duties to the Test Technician; selects and purchases needed test equipment and generates necessary "Request for Purchase" forms; is responsible for design and fabrication of laboratory testing facilities; executes tests on Class 1E electrical components in conjunction with the Senior Research Engineer and/or Senior Test Engineer; maintains, updates, and reviews a calibrated equipment data base in conjunction with the I&C Officer; and works on various other projects as required by present priority.

9. Test Technician

The Test Technician executes tasks as designated by the Assistant Project Engineers, Senior Research Engineer, and/or Senior Test Engineer; performs routine calibration of laboratory test equipment in accordance with written calibration procedures; and is responsible for general laboratory upkeep and routine equipment maintenance.

II. QUALITY ASSURANCE PROGRAM OF RDI

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The Quality Assurance (QA) Program of RDI relating to a Nuclear Reactor Component Qualification Program is applicable to all personnel associated with the project, as presented in Criterion I, "Organization." The program basically consists of three components:

1. Quality assurance of testing sequence and procedures

2. Quality assurance education program

3. General QA monitoring by QA Officer.

II.1. QA of Testing Procedures and Sequence

Prior to testing of each component (or type of component), equipment performance specifications will be supplied to RDI by the client. In accordance with IEEE Standard 323-1983, these specifications shall include the following:

1. Performance characteristics under defined normal, abnormal, containment test, design basis event, and post-design basis event conditions.

2. The range of voltage, frequency, load, electromagnetic interference, and other electrical characteristics.

3. The installation requirements, including mounting method and configurations.

4. Preventive maintenance schedule for the installed life of the equipment (including lubricants and seals).

5. The design life of the equipment and the design life of any components which may have a life shorter than that of the complete equipment.

6. Control, indicating, and other auxiliary devices contained in the equipment or external to the equipment and required for proper operation.

7. The range, type, and duration of environmental conditions, including temperature, pressure, humidity, radiation, chemicals, and seismic forces.

8. Complete description and number of operating cycles, including periodic testing.

9. The safety-related function of the component, including the required accuracies for this safety function.

After the specifications have been received, the Senior Test Engineer or the Senior Research Engineer shall prepare a test plan. The QA Officer verifies that the specifications have been received. The QA Officer shall verify and sign each test plan. In accordance with IEEE Standard 323-1983, these plans will contain as much of the following information as is required by the client:

1. Equipment descriptions

2. Number (quantity) of units to be tested

3. Mounting and connection requirements

4. Aging simulation procedure

5. The service conditions to be simulated

6. Performance and environment variables to be measured

7. Test equipment requirements, including accuracies

8. Environmental, operating, and measurement sequence in step-by-step detail

9. Performance limits or failure definition

10. Documentation (Section 8.3)

11. Statement of nonapplicable portions of the specification

12. A description of any conditions peculiar to the equipment which are not covered above, but which would probably affect said equipment during testing.

The RDI QA Officer will verify and sign each test plan. Consistent with IEEE Standard 323-1983, each component will undergo the appropriate portions of the following testing under the direction of the Senior Test Engineer and will be monitored by the QA Officer:

TYPICAL TEST SEQUENCE FOR QUALIFYING CLASS 1E EQUIPMENT FOR NUCLEAR POWER GENERATING STATIONS

1. Inspection for shipping damage prior to testing

2. Performance Test

3. Specification Extremes Test

    a. Continuously monitor operability status

    b. Periodically interrupt test and do Performance Test

4. Performance Test

5. Aging Test (Including Irradiation)

    a. Continuously monitor temperature during thermal aging

    b. Periodically interrupt test and do Performance Test

6. Performance Test

7. Seismic Test

    a. Perform at least 5 OBE's (Operating Basis Earthquake)

        (1) Continuously monitor operability status

        (2) Performance Test after each OBE Test

    b. Perform at least 1 SSE (Safety Shutdown Earthquake)

        (1) Continuously monitor operability status

        (2) Performance Test after each SSE Test

8. Non-Seismic Vibration Test (not necessary on all components)

   a. Continuously monitor operability status

   b. Periodically interrupt test and do Performance Test

9. Performance Test

10. Simulated Design Basis Test and Post-Design Basis Test

    a. Continuously monitor operability status

11. Performance Test

12. Disassemble device, as necessary, to determine condition of equipment.

The testing of each component shall be documented according to the documentation plan presented later in this manual. The QA Officer will monitor the testing to ensure that approved procedures are being properly implemented. At the conclusion of the testing (and documentation thereof), the QA Officer will verify and sign that the testing has been conducted properly and that the data substantiates the requested qualification of that component by the NRC. A request will normally be made of the NRC by the client that the component be qualified for a specific life period. In certain cases, this request may be made by RDI. Accompanying each such request will be the completed checklist, shown here as Table I.

In addition to verifying to the testing flowchart and procedures, the QA Officer or the Senior Test Engineer will verify that the calibration of each piece of testing equipment used during the work is traceable to NBS standards (to be discussed in a later section), and is within the specified calibration cycle. Upon

TABLE I

TYPICAL CHECKLIST FOR EACH CLASS 1E COMPONENT

		Date	QA Officer Signature
1.	Complete Specifications Received from Client		
2.	Test Plan Complete for Submission to Client		
3.	Test Sequence as Follows:		
	a. Inspection for Shipping Damage		
	b. Performance Test		
	c. Specification Extremes Test		
	d. Performance Test		
	e. Aging Tests		
	Irradiation		
	Thermal		
	f. Performance Test		
	g. Seismic Tests		
	OBE's		
	SSE		
	h. Non-Seismic Vibration Test (if required)		
	i. Performance Test		
	j. Simulated Design and Post-Design Basis Tests		
	k. Performance Test		
	l. Disassembly Inspection		
4.	Documentation Complete		
5.	Qualification Package Is Complete		

receipt of a piece of QA testing equipment (verified received as ordered by the Purchasing Controller), the QA Officer, working in conjunction with the I&C Officer, will establish the initial calibration cycle. After NBS traceable calibration has been verified by the I&C Officer, he will attach a calibration sticker which will contain the calibration date and calibration cycle and be signed by the QA Officer. The I&C Officer will maintain a file on each piece of QA testing equipment, which will be audited periodically by the QA Officer.

II.2. QA Educational Program

The previous paragraphs have described the QA Program to be implemented during the component testing program. Although this is the heart of the program, a significant portion is the QA Educational Program which will contain the following:

1. RDI Introductory QA Training

Each member of the RDI Project Team will be supplied at the onset of the program with copies of 10CFR50.49, IEEE Standard 323-1983, IEEE Standard 344-1975, the QA Manual, and Implementation Procedures for 10CFR50, Appendix B. Two indoctrination lecture and discussion sessions will then be conducted. The first session will cover the NRC regulations (the above applicable documents) and will be presented by the Program Manager, if possible, in conjunction with the client's Liaison Representative. The second session will cover the QA Manual and the execution of the RDI QA Program and will be presented by the QA Officer.

2. Handling of Test Equipment

The Senior Test Engineer, in conjunction with the QA Officer, will ensure that the project personnel are adequately trained in the proper handling of the test equipment by methods which will not compromise the component's quality or intended use.

3. Ongoing Education Program

The project technical staff will be given periodic briefings and discussion sessions by the QA Officer, who will discuss the progress in implementation of the QA plans, QA problem areas, and other pertinent matters.

II.3 General Monitoring by QA Officer

In addition to the above two categories of the RDI QA Program, the QA Officer will monitor, and report directly to the President of RDI, the following areas:

1. Verify that proper procedures are available, are understood, and are implemented.

2. Verify the skills of the personnel.

3. Verify that appropriate and qualified tools are available to, and are being used by, the project personnel.

4. Verify that the conditions for the performance of the job exist and are defined.

5. Audit the procurement of testing equipment or other components, and verify that proper documentation exists in this regard.

6. Review, with the Program Manager, the QA Program on an annual basis.

IV. PROCUREMENT DOCUMENT CONTROL

IV. PROCUREMENT DOCUMENT CONTROL

All "Request for Purchase" forms will be logged and designated as either QA or non-QA items. All "Request for Purchase" forms for non-QA items must be approved and signed by the Senior Test Engineer. All "Request for Purchase" forms for QA items must be approved and signed by the QA Officer in addition to the Senior Test Engineer. Prior to release of "Request for Purchase" forms, the QA Officer will review the form to assure that quality, testing, and/or regulatory requirements have been specified. Where applicable, the Purchase Order will contain the notification that compliance with 10CFR Part 21 and 10CFR50, Appendix B is required of the supplier. Copies of all "Request for Purchase" forms and corresponding Purchase Orders are maintained by the Purchasing Controller. The QA Officer will periodically audit the Purchasing Controller's file of "Request for Purchase" forms and Purchase Orders. The file will be available for review and/or audit by designated personnel of the client.

As discussed in the QA Program, as new QA equipment arrives, it will be inspected by the Purchasing Controller and the QA and I&C Officers to ensure conformance with the Purchase Order. Components not meeting specification requirements will be returned or, if kept, shall be stored in a cabinet marked, "Out-of-Calibration Equipment," to ensure that they are not inadvertently used. QA equipment previously procured will be reinspected and tested as if it were just newly purchased. The I&C Officer will maintain a file on the testing, inspection, and calibration of each piece of QA testing equipment. The QA Officer will review this file, as previously stated.

In addition, the QA Officer will assure that all subcontractors have procurement records and maintain a QA Program consistent with 10CFR50, Appendix B and 10CFR21.

V. INSTRUCTIONS, PROCEDURES, AND DRAWINGS

V. INSTRUCTIONS, PROCEDURES, AND DRAWINGS

The overriding instructions and procedures governing this program rest with the documentation required by the NRC for qualifying the components. As stated in IEEE Standard 323-1983, this required documentation is as follows for type test data:

1. The equipment performance specifications

2. Identification of the specific feature(s) to be demonstrated by the test

3. Test Plan

4. Report of test results. The report shall include:
   a. Objective
   b. Equipment tested
   c. Description of test facility (test setup) and instrumenation used, including calibration record reference
   d. Test procedures
   e. Test data and accuracy (results)
   f. Summary, conclusions, and recommendations
   g. Supporting data
   h. Approval signature and date.

Included in the Test Plan will be a description of the QA Officer's participation during the test, as will be finalized by his signing of the form shown as Table I in Section II of this manual. The training of the project personnel in

this required documentation is a part of the RDI QA Program, as presented previously. Any change in this documenation must be justifiable to NRC.

Any drawings generated by a testing program, such as those for the construction of the chamber for the simulated design and post-design basis tests, the aging chambers, mounting equipment, etc., will be filed with the procurement file of the Purchasing Controller. The client will supply the needed drawings on the Class 1E components to be tested, which will be a part of the Specifications, as stated in the QA Program.

The instructions for applicable acceptance criteria are a part of the test plan for each component, as required by NRC, and presented previously. The major testing activities are identical for the Class 1E components and are checked by the QA Officer on his checklist (see Table I under QA Program).

The QA Officer will inspect incoming materials and equipment, as specified in Section VII of this manual. He will also conduct audits according to Section XVIII of this manual and will check for nonconforming material, according to Section XV of this manual.

VI. DOCUMENT CONTROL

VI. DOCUMENT CONTROL

In general, the client will perform all official correspondence with NRC. Therefore, the anticipated flow of documents is as follows:

1. Between the client and RDI
2. Between RDI and its subcontractors
3. Between RDI and testing equipment vendors
4. RDI internal documents relating to the program
5. Significant RDI miscellaneous correspondence.

The client will maintain the official file of all documentation referred to in IEEE Standard 323-1983 (see Criterion V). RDI will maintain a duplicate file of this material.

J.W. Anno, Administrative Assistant (corporate officer of RDI), as shown on the Organization Chart of Figure 1, will serve as Document Controller and maintain the official file on the flow of all documents (other than Purchase Orders and drawings maintained by the Purchasing Controller, the Corrective Action file maintained by the QA Officer, and the test equipment file maintained by the I&C Officer). The Document Controller will maintain the official file, log in and out documents, and assign consecutive document numbers to documents as follows (numbers to be marked on original and all copies):

DOCUMENT	DOCUMENT CODE
Client, In	RDI-CI- _ _ _ _ (Consecutive #'s)
Client, Out	RDI-CO- _ _ _ _
UC, In	RDI-UI- _ _ _ _
UC, Out	RDI-UO- _ _ _ _
F&H, In	RDI-FI- _ _ _ _
F&H, Out	RDI-FO- _ _ _ _
Vendor, In	RDI-VI- _ _ _ _
Vendor, Out	RDI-VO- _ _ _ _
RDI Internal	RDI-INT- _ _ _ _
RDI Miscellaneous	RDI-MISC- _ _ _ _
NRC, In	RDI-NRCI- _ _ _ _
NRC, Out	RDI-NRCO- _ _ _ _

Other categories may be added or any existing category may be discontinued, if necessary.

When a document with instructions, procedures, or other vital information is superseded by a later one, the new document will be marked, "Supersedes RDI-_ _ _ - _ _ _ _," and the superseded document will be marked, "Superseded by RDI- _ _ _ - _ _ _ _." Any changes so occurring will be approved by the appropriate personnel. Issues directly bearing on quality assurance will require the approval of the QA Officer. Any document containing typographical errors can be corrected and marked "Corrected Copy."

The distribution of all documents shall be controlled by the Program Manager. Documents bearing information relating to quality assurance shall have, at a minimum, the distribution of the Program Manager, QA Officer, and Senior Test Engineer.

Copies of all documents officially logged pertaining to this program shall be retained at least two years after the completion of the program, and its possible extensions. Storage shall be in a Class D, fire-insulated file cabinet in accordance with ANSI N45.2.9-1974, "Requirements for Collection, Storage, and Maintenance of Quality Assurance Records for Nuclear Power Plants."

VII. CONTROL OF PURCHASED MATERIAL, EQUIPMENT, AND SERVICES

VII. CONTROL OF PURCHASED MATERIAL, EQUIPMENT, AND SERVICES

The Corporate Vice President and General Manager and Purchasing Controller, as presented in Criterion I, "Organization," has direct control of all purchases and subcontract services.

Two categories of purchased material and equipment have been established. One category is material and equipment that must satisfy the QA requirements, referred to as QA material or QA equipment. The other category is material and equipment that does not have to satisfy the QA requirements, referred to as non-QA material or non-QA equipment. Any item that can affect the quality of the test results produced under this program shall be designated QA material or QA equipment. Examples of non-QA material or non-QA equipment are tools, hardware, tape, pipe fittings, office supplies, etc. The Senior Test Engineer shall note on the "Request for Purchase" form whether the material is QA or non-QA material. The QA Officer shall review these decisions when he audits the Purchasing Controller's Purchase Order File.

Upon receipt of QA items, the I&C Officer will inspect the shipment to ensure that the received items concur with the items on the Purchase Order and have not been damaged in shipping. The I&C Officer shall attach a red tag to the material, noting any discrepancies or damage. Red-tagged equipment/material shall not be used for data acquisition or for any purpose which can affect the quality of test results. The Purchasing Controller shall note on the appropriate Purchase Order that the received items did or did not concur with the Purchase Order and were or were not damaged in shipping. The Purchasing Controller shall initial and date the red tag to indicate that he has noted the condition of this

material/equipment. The I&C Officer shall affix an ID number to all items of sufficient size to accommodate such a number which have passed receiving inspection. The I&C Officer shall determine if the material needs a calibration procedure and schedule. If it does, he, with the cooperation of the QA Officer, shall establish said procedure and schedule. The QA Officer shall review the records on the received material and authorize the I&C Officer to replace the red tag with a green tag. The QA Officer shall initial and date the green tag to note his approval. If the item requires calibration, the I&C Officer shall affix a calibration sticker to the equipment. The calibration sticker shall contain the calibration cycle and be initialed by the QA Officer to indicate his approval.

Original operating and information manuals for all QA equipment will be filed by the I&C Officer. These manuals will be available for field use by test technicians or engineers who may need them for equipment operation or procedure preparation.

QA materials and equipment purchased by UC (one of the subcontractors) shall conform to the above requirements. The RDI QA Officer reviews, approves, and signs off on these purchases.

Services purchased from Farwell & Hendricks, Inc. shall conform to the requirements of 10CFR50, Appendix B and 10CFR21, Code of Federal Regulations. Confirmation shall be monitored by the RDI QA Officer.

VIII. IDENTIFICATION AND CONTROL OF MATERIALS, PARTS, AND COMPONENTS

VIII. IDENTIFICATION AND CONTROL OF MATERIALS, PARTS, AND COMPONENTS

Most material, parts, and components to be used on this program are test instruments, with several test chambers and a boiler available for the aging and simulation event tests. The Purchasing Controller will maintain records, permitting the traceability of each item to its vendor.

Nevertheless, material, parts, and components used to conduct the testing of the Class 1E components shall be identified in two manners:

1. An ID number will be assigned to each QA component according to the code TC-_ _ _ _(consecutive numbers). This ID number, whenever possible, will be affixed to the component. A file will be maintained by the I&C Officer identifying the component by its number and listing the calibration and/or maintenance record of that component.

2. A tag will be placed on each component which will report the latest calibration date and the calibration cycle. As discussed in Criterion II, the QA Officer will sign each tag after calibration, attesting that the calibration was performed according to established standards.

As mentioned above, the I&C Officer will maintain the calibration records to support the required accuracy of each instrument. In conjunction with the QA Officer, a calibration cycle will be established, commensurate with the frequency of use, the importance of the item, and the manufacturer's recommendation. For further control, see Section XII of this manual.

X. INSPECTION

X. INSPECTION

Testing and inspection shall be performed in accordance with the procedures stated in this manual. The following inspection occurs:

1. Of Test Equipment

    a. Purchasing Controller, upon receipt

    b. I&C Officer, upon calibration

    c. QA Officer, in conjunction with I&C Officer

    d. Continual I&C and QA Officers' inspection upon maintenance and recalibration.

2. Of Testing

    a. QA Officer monitors testing to assure compliance with procedures

    b. QA Officer, upon satisfaction with the testing, so attests by signing off on form shown in this manual as Table I in Section II

    c. The QA Officer has the authority to stop all testing if he sees a procedure violation or nonconformance.

The personnel performing inspections shall be trained in procedures in accordance with this manual during the RDI QA Educational Program, as stated in Criterion II.2. If the results of any inspection show lack of quality, the appropriate inspector is to place the equipment or service on "hold" and report the matter immediately to the Program Manager for resolution.

XI. TEST CONTROL

XI. TEST CONTROL

Testing shall be conducted in accordance with 10CFR50.49, IEEE Standard 323-1983, and applicable daughter standards. The test plans required by NRC for each component will clearly define the method, intent, and acceptance criteria for each test. The test results will be documented according to IEEE Standard 323-1983 (see Criterion V, "Instructions, Procedures, and Drawings"). The status of the test procedure implementation will be evident from the records, tagging, and similar documentation, as applicable. All operational manipulation of the test equipment shall be performed by RDI personnel (see Criterion I, "Organization"). This includes taking the data on the components in the seismic tests to be performed at the subcontractor site. RDI personnel and testing equipment will be transported to this site, as per agreement, to perform the monitoring of the component(s) performance and operability. Test results which do not comply with the acceptance criteria established in the test plan shall be documented and submitted likewise to the client.

The QA Officer will assure that test procedures are of quality, and so designate by approval of the test plans (see Table I in Section II of this manual). He will monitor the testing by both RDI personnel and its subcontractors, and so attest by approval of item 3 in Table I in Section II of this manual. Any QA problems shall be brought to the attention of the Program Manager, according to Section XVI, "Corrective Action," of this manual.

XII. CONTROL OF MEASURING AND TEST EQUIPMENT

XII. CONTROL OF MEASURING AND TEST EQUIPMENT

This manual has stated the principal procedures covering the control of measuring and test equipment. These procedures will assure that all equipment is clearly identified and controlled to assure the validity and traceability of test results. The equipment shall be calibrated by qualified personnel in accordance with a schedule which considers the importance of the test results and frequency for equipment recalibration. Calibration shall be performed, recorded, and traceable to standards complying with the National Bureau of Standards (NBS) requirements.

Test results shall record the instrument identification number (TC-_ _ _ _) [see Criterion VIII] utilized in the conduct of this test. The Senior Test Engineer, in conjunction with the QA Officer, will assure that testing personnel are trained and qualified in the use of the measuring and test equipment. QA test equipment which is not in calibration will not be used in the testing. Such calibration will be clearly marked on the tags affixed to the instruments. Any nonconformance of QA testing equipment used in testing will be reported in accordance with 10CFR21 and 10CFR50, Appendix B.

XIII. HANDLING, STORAGE, AND SHIPPING

XIII. HANDLING, STORAGE, AND SHIPPING

QA equipment used for testing shall be handled, stored, and shipped in a manner commensurate with the delicacy and accuracy to be maintained for the purpose of each test specimen. When not in use, QA testing equipment will be stored in a limited access laboratory space that is controlled against extreme fluctuations in temperature. The transportation of the test specimen and QA testing equipment to any subcontractor site will be performed only by RDI personnel under controlled conditions. The required functional performance and baseline testing of the specimen being type-tested will be checked after each transport.

As a part of the QA Educational Program (see Criterion II.2), the appropriate personnel will be trained to handle testing equipment in methods which will not compromise the quality or intended use of the test specimen.

XIV. INSPECTION, TEST, AND OPERATING STATUS

XIV. INSPECTION, TEST, AND OPERATING STATUS

The primary systems to be used in this program requiring operability are the testing equipment. A pretest checklist will be completed and approved by the Senior Test Engineer or Senior Research Engineer to ensure that all QA test equipment is functional and within the calibration cycle. RDI personnel, as a part of the QA Educational Program, will be instructed to report inoperability of any QA equipment immediately to the I&C Officer, who will tag that piece of equipment as inoperable. Said tag shall not be removed until the equipment is restored to its operation and recalibrated. The I&C Officer will document the release and action on the piece of equipment on his file sheet for that particular item (see Criterion VIII, "Identification and Control of Materials, Parts, and Components"). The date of the release of the system shall also be documented.

XV. NONCONFORMING MATERIALS, PARTS, OR COMPONENTS

XV. NONCONFORMING MATERIALS, PARTS, OR COMPONENTS

Materials, parts, or components (in this program, primarily testing equipment) nonconforming to predetermined acceptance criteria shall be documented on an appropriate form (shown as Table II of this manual). Each component undergoes three initial checks:

1. Inspection by the Purchasing Controller for conformity with purchase request
2. Inspection by I&C Officer during check-out and calibration
3. Inspection by QA Officer confirming acceptance.

If an item is initially found to be nonconforming, it will be documented on the appropriate document in one of the three above steps. Nonconformance later in the program will be reported immediately by the testing personnel to the I&C Officer and the QA Officer, and the component so tagged (see Criterion XIV). Nonconforming or items which deviate from testing or installation criteria shall be dispositioned by the Purchasing Controller, once tagged, and confirmed by the QA Officer. The QA Officer shall periodically review all nonconformance reports with the Program Manager. Any component or test specimen which fails during testing will be documented and reported according to 10CFR21.

TABLE II

REPORT OF NONCONFORMING MATERIAL

TO: QA OFFICER

The following material, part, or component

____

(include RDI inventory number, where appropriate) has been found to be nonconforming during one of the following inspections:

	Checks	Initial
1. By Purchasing Controller for conformity with purchase request	______	______
2. BY I&C Officer during		
a. Initial check-out	______	______
b. Calibration	______	______
3. By QA Officer	______	______

It has been so tagged and requires disposition.

Signed:______________________________

Date:______________________________

Received and acted upon by QA Officer.

Signed:______________________________

Date:______________________________

XVI. CORRECTIVE ACTION

XVI. CORRECTIVE ACTION

Conditions adverse to quality which are identified through audit inspection, testing or other means, and so documented, shall require implementation of corrective action. The corrective action will identify the cause of deviation, what will be done to correct the condition, and what will be done to avoid further nonconformance.

The requirement for corrective action will usually be initiated by the QA Officer, but can be initiated by any of the project personnel, or at the request of the auditor (see Criterion XVIII). The corrective action will be documented on the form (or appended thereto) which initiated the corrective action, and the implementation shall be verified by the QA Officer. The QA Officer will maintain the file of corrective action documentation.

Audits revealing nonconformance or nonconformance identified during system testing shall require submittal of required corrective action.

This portion of the manual interfaces with Sections XV and XVIII.

XVII. QUALITY ASSURANCE RECORDS

XVII. QUALITY ASSURANCE RECORDS

The records which will demonstrate the quality assurance of this program shall be kept and maintained as presented in this manual. The I&C Officer shall maintain a file on test equipment maintenance and calibration. The documentation of test results will be in accordance with IEEE Standard 323-1983 (see Criterion V in this manual). The client will maintain the permanent file of this documentation, as submitted to them by RDI. RDI will maintain duplicate files. The test documentation shall be legible, complete, retrievable, and formally submitted to the client as official documents (see Criterion VI, "Document Control," of this manual). Changes to records shall formally be initialled and dated at the time of revision, and appropriate notification given to the client in instances where such records have been formally transmitted to them from RDI.

XVIII. AUDITS

XVIII. AUDITS

Audits will be conducted periodically by the RDI QA Officer to assure compliance with the QA Manual and the following regulations:

10CFR50, Appendix B

10CFR21

10CFR50.49

IEEE Standard 323-1983

IEEE Standard 344-1975

Copies documenting the results of each audit will be distributed to every member of the project team, as presented in Section I, "Organization," of this manual. The exact time of the audits will be unannounced.

Corrective action implementation in response to audits shall be verified by the QA Officer. Copies of the audits shall be retained for future reference and assurance that the QA Program was implemented and/or corrected as necessary. The Document Controller shall maintain the official file of the audit documents, with the QA Officer maintaining a duplicate file.

The audits shall be conducted in accordance with the various duties of the QA Officer (as stated in this manual) and shall include audits of procedures, documentation, personnel skills, test equipment, administrative and on-site conditions, and equipment procurement.

Upon 24-hours notification, in writing, designated personnel of the client may audit the QA documentation of RDI on a testing program.

APPENDIX I

10CFR50, APPENDIX B

QUALITY ASSURANCE CRITERIA FOR

NUCLEAR POWER PLANTS AND FUEL REPROCESSING PLANTS

APPENDIX B—QUALITY ASSURANCE CRITERIA FOR NUCLEAR POWER PLANTS AND FUEL REPROCESSING PLANTS *

Introduction. Every applicant for a construction permit is required by the provisions of § 50.34 to include in its preliminary safety analysis report a description of the quality assurance program to be applied to the design, fabrication, construction, and testing of the structures, systems, and components of the facility. Every applicant for an operating license is required to include, in its final safety analysis report, information pertaining to the managerial and administrative controls to be used to assure safe operation. Nuclear power plants and fuel reprocessing plants include structures, systems, and components that prevent or mitigate the consequences of postulated accidents that could cause undue risk to the health and safety of the public. This appendix establishes quality assurance requirements for the design, construction, and operation of those structures, systems, and components. The pertinent requirements of this appendix apply to all activities affecting the safety-related functions of those structures, systems, and components; these activities include designing, purchasing, fabricating, handling, shipping, storing, cleaning, erecting, installing, inspecting, testing, operating, maintaining, repairing, refueling, and modifying.

As used in this appendix, "quality assurance" comprises all those planned and systematic actions necessary to provide adequate confidence that a structure, system, or component will perform satisfactorily in service. Quality assurance includes quality control, which comprises those quality assurance actions related to the physical characteristics of a material, structure, component, or system which provide a means to control the quality of the material, structure, component, or system to predetermined requirements.

I. ORGANIZATION

The applicant[1] shall be responsible for the establishment and execution of the quality assurance program. The applicant may delegate to others, such as contractors, agents, or consultants, the work of establishing and executing the quality assurance program, or any part thereof, but shall retain responsibility therefor. The authority and duties of persons and organizations performing activities affecting the safety-related functions of structures, systems, and components shall be clearly established and delineated in writing. These activities include both the performing functions of attaining quality objectives and the quality assurance functions. The quality assurance functions are those of (a) assuring that an appropriate quality assurance program is established and effectively executed and (b) verifying, such as by checking, auditing, and inspection, that activities affecting the safety-related functions have been correctly performed. The persons and organizations performing quality assurance functions shall have sufficient authority and organizational freedom to identify quality problems; to initiate, recommend, or provide solutions; and to verify implementation of solutions. Such persons and organizations performing quality assurance functions shall report to a management level such that this required authority and organizational freedom, including sufficient independence from cost and schedule when opposed to safety considerations, are provided. Because of the many variables involved, such as the number of personnel, the type of activity being performed, and the location or locations where activities are performed, the organizational structure for executing the quality assurance program may take various forms provided that the persons and organizations assigned the quality assurance functions have this required authority and organizational freedom. Irrespective of the organizational structure, the individual(s) assigned the responsibility for assuring effective execution of any portion of the quality assurance program at any location where activities subject to this appendix are being performed shall have direct access to such levels of management as may be necessary to perform this function.

II. QUALITY ASSURANCE PROGRAM

The applicant shall establish at the earliest practicable time, consistent with the schedule for accomplishing the activities, a quality assurance program which complies with the requirements of this appendix. This program shall be documented by written policies, procedures, or instructions and shall be carried out throughout plant life in accordance with those policies, procedures, or instructions. The applicant shall identify the structures, systems, and components to be covered by the quality assurance program and the major organizations participating in the program, together with the designated functions of these organizations. The quality assurance program shall provide control over activities affecting the quality of the identified structures, systems, and components, to an extent consistent with their importance to safety. Activities affecting quality shall be accomplished

[1] While the term "applicant" is used in these criteria, the requirements are, of course, applicable after such a person has received a license to construct and operate a nuclear powerplant or a fuel reprocessing plant. These criteria will also be used for guidance in evaluating the adequacy of quality assurance programs in use by holders of construction permits and operating licenses.

* Code of Federal Regulations, Title 10 - Energy, Parts 0 to 199, Revised as of January 1, 1983

under suitably controlled conditions. Controlled conditions include the use of appropriate equipment; suitable environmental conditions for accomplishing the activity, such as adequate cleanness; and assurance that all prerequisites for the given activity have been satisfied. The program shall take into account the need for special controls, processes, test equipment, tools, and skills to attain the required quality, and the need for verification of quality by inspection and test. The program shall provide for indoctrination and training of personnel performing activities affecting quality as necessary to assure that suitable proficiency is achieved and maintained. The applicant shall regularly review the status and adequacy of the quality assurance program. Management of other organizations participating in the quality assurance program shall regularly review the status and adequacy of that part of the quality assurance program which they are executing.

III. DESIGN CONTROL

Measures shall be established to assure that applicable regulatory requirements and the design basis, as defined in § 50.2 and as specified in the license application, for those structures, systems, and components to which this appendix applies are correctly translated into specifications, drawings, procedures, and instructions. These measures shall include provisions to assure that appropriate quality standards are specified and included in design documents and that deviations from such standards are controlled. Measures shall also be established for the selection and review for suitability of application of materials, parts, equipment, and processes that are essential to the safety-related functions of the structures, systems and components.

Measures shall be established for the identification and control of design interfaces and for coordination among participating design organizations. These measures shall include the establishment of procedures among participating design organizations for the review, approval, release, distribution, and revision of documents involving design interfaces.

The design control measures shall provide for verifying or checking the adequacy of design, such as by the performance of design reviews, by the use of alternate or simplified calculational methods, or by the performance of a suitable testing program. The verifying or checking process shall be performed by individuals or groups other than those who performed the original design, but who may be from the same organization. Where a test program is used to verify the adequacy of a specific design feature in lieu of other verifying or checking processes, it shall include suitable qualifications testing of a prototype unit under the most adverse design conditions. Design control measures shall be applied to items such as the following: reactor physics, stress, thermal, hydraulic, and accident analyses; compatibility of materials; accessibility for inservice inspection, maintenance, and repair; and delineation of acceptance criteria for inspections and tests.

Design changes, including field changes, shall be subject to design control measures commensurate with those applied to the original design and be approved by the organization that performed the original design unless the applicant designates another responsible organization.

IV. PROCUREMENT DOCUMENT CONTROL

Measures shall be established to assure that applicable regulatory requirements, design bases, and other requirements which are necessary to assure adequate quality are suitably included or referenced in the documents for procurement of material, equipment, and services, whether purchased by the applicant or by its contractors or subcontractors. To the extent necessary, procurement documents shall require contractors or subcontractors to provide a quality assurance program consistent with the pertinent provisions of this appendix.

V. INSTRUCTIONS, PROCEDURES, AND DRAWINGS

Activities affecting quality shall be prescribed by documented instructions, procedures, or drawings, of a type appropriate to the circumstances and shall be accomplished in accordance with these instructions, procedures, or drawings. Instructions, procedures, or drawings shall include appropriate quantitative or qualitative acceptance criteria for determining that important activities have been satisfactorily accomplished.

VI. DOCUMENT CONTROL

Measures shall be established to control the issuance of documents, such as instructions, procedures, and drawings, including changes thereto, which prescribe all activities affecting quality. These measures shall assure that documents, including changes, are reviewed for adequacy and approved for release by authorized personnel and are distributed to and used at the location where the prescribed activity is performed. Changes to documents shall be reviewed and approved by the same organizations that performed the original review and approval unless the applicant designates another responsible organization.

VII. CONTROL OF PURCHASED MATERIAL, EQUIPMENT, AND SERVICES

Measures shall be established to assure that purchased material, equipment, and services, whether purchased directly or through contractors and subcontractors, conform to the procurement documents. These measures shall include provisions, as

appropriate, for source evaluation and selection, objective evidence of quality furnished by the contractor or subcontractor, inspection at the contractor or subcontractor source, and examination of products upon delivery. Documentary evidence that material and equipment conform to the procurement requirements shall be available at the nuclear powerplant or fuel reprocessing plant site prior to installation or use of such material and equipment. This documentary evidence shall be retained at the nuclear powerplant or fuel reprocessing plant site and shall be sufficient to identify the specific requirements, such as codes, standards, or specifications, met by the purchased material and equipment. The effectiveness of the control of quality by contractors and subcontractors shall be assessed by the applicant or designee at intervals consistent with the importance, complexity, and quantity of the product or services.

VIII. IDENTIFICATION AND CONTROL OF MATERIALS, PARTS, AND COMPONENTS

Measures shall be established for the identification and control of materials, parts, and components, including partially fabricated assemblies. These measures shall assure that identification of the item is maintained by heat number, part number, serial number, or other appropriate means, either on the item or on records traceable to the item, as required throughout fabrication, erection, installation, and use of the item. These identification and control measures shall be designed to prevent the use of incorrect or defective material, parts, and components.

IX. CONTROL OF SPECIAL PROCESSES

Measures shall be established to assure that special processes, including welding, heat treating, and nondestructive testing, are controlled and accomplished by qualified personnel using qualified procedures in accordance with applicable codes, standards, specifications, criteria, and other special requirements.

X. INSPECTION

A program for inspection of activities affecting quality shall be established and executed by or for the organization performing the activity to verify conformance with the documented instructions, procedures, and drawings for accomplishing the activity. Such inspection shall be performed by individuals other than those who performed the activity being inspected. Examinations, measurements, or tests of material or products processed shall be performed for each work operation where necessary to assure quality. If inspection of processed material or products is impossible or disadvantageous, indirect control by monitoring processing methods, equipment, and personnel shall be provided. Both inspection and process monitoring shall be provided when control is inadequate without both. If mandatory inspection hold points, which require witnessing or inspecting by the applicant's designated representative and beyond which work shall not proceed without the consent of its designated representative are required, the specific hold points shall be indicated in appropriate documents.

XI. TEST CONTROL

A test program shall be established to assure that all testing required to demonstrate that structures, systems, and components will perform satisfactorily in service is identified and performed in accordance with written test procedures which incorporate the requirements and acceptance limits contained in applicable design documents. The test program shall include, as appropriate, proof tests prior to installation, preoperational tests, and operational tests during nuclear power plant or fuel reprocessing plant operation, of structures, systems, and components. Test procedures shall include provisions for assuring that all prerequisites for the given test have been met, that adequate test instrumentation is available and used, and that the test is performed under suitable environmental conditions. Test results shall be documented and evaluated to assure that test requirements have been satisfied.

XII. CONTROL OF MEASURING AND TEST EQUIPMENT

Measures shall be established to assure that tools, gages, instruments, and other measuring and testing devices used in activities affecting quality are properly controlled, calibrated, and adjusted at specified periods to maintain accuracy within necessary limits.

XIII. HANDLING, STORAGE AND SHIPPING

Measures shall be established to control the handling, storage, shipping, cleaning and preservation of material and equipment in accordance with work and inspection instructions to prevent damage or deterioration. When necessary for particular products, special protective environments, such as inert gas atmosphere, specific moisture content levels, and temperature levels, shall be specified and provided.

XIV. INSPECTION, TEST, AND OPERATING STATUS

Measures shall be established to indicate, by the use of markings such as stamps, tags, labels, routing cards, or other suitable means, the status of inspections and tests performed upon individual items of the nuclear power plant or fuel reprocessing plant. These measures shall provide for the identification of items which have satisfactorily

passed required inspections and tests, where necessary to preclude inadvertent bypassing of such inspections and tests. Measures shall also be established for indicating the operating status of structures, systems, and components of the nuclear power plant or fuel reprocessing plant, such as by tagging valves and switches, to prevent inadvertent operation.

XV. NONCONFORMING MATERIALS, PARTS, OR COMPONENTS

Measures shall be established to control materials, parts, or components which do not conform to requirements in order to prevent their inadvertent use or installation. These measures shall include, as appropriate, procedures for identification, documentation, segregation, disposition, and notification to affected organizations. Nonconforming items shall be reviewed and accepted, rejected, repaired or reworked in accordance with documented procedures.

XVI. CORRECTIVE ACTION

Measures shall be established to assure that conditions adverse to quality, such as failures, malfunctions, deficiencies, deviations, defective material and equipment, and nonconformances are promptly identified and corrected. In the case of significant conditions adverse to quality, the measures shall assure that the cause of the condition is determined and corrective action taken to preclude repetition. The identification of the significant condition adverse to quality, the cause of the condition, and the corrective action taken shall be documented and reported to appropriate levels of management.

XVII. QUALITY ASSURANCE RECORDS

Sufficient records shall be maintained to furnish evidence of activities affecting quality. The records shall include at least the following: Operating logs and the results of reviews, inspections, tests, audits, monitoring of work performance, and materials analyses. The records shall also include closely-related data such as qualifications of personnel, procedures, and equipment. Inspection and test records shall, as a minimum, identify the inspector or data recorder, the type of observation, the results, the acceptability, and the action taken in connection with any deficiencies noted. Records shall be identifiable and retrievable. Consistent with applicable regulatory requirements, the applicant shall establish requirements concerning record retention, such as duration, location, and assigned responsibility.

XVIII. AUDITS

A comprehensive system of planned and periodic audits shall be carried out to verify compliance with all aspects of the quality assurance program and to determine the effectiveness of the program. The audits shall be performed in accordance with the written procedures or check lists by appropriately trained personnel not having direct responsibilities in the areas being audited. Audit results shall be documented and reviewed by management having responsibility in the area audited. Followup action, including reaudit of deficient areas, shall be taken where indicated.

[35 FR 10499, June 27, 1970, as amended at 36 FR 18301, Sept. 17, 1971; 40 FR 3210D, Jan. 20, 1975]

APPENDIX II

10CFR21

APPENDIX D—UNITED STATES NUCLEAR REGULATORY COMMISSION REGIONAL OFFICES

	Address	Telephone (24 hrs)
Region I: Connecticut, Delaware, District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont	USNRC, 631 Park Ave., King of Prussia, PA 19406	(215) 337-5000, (FTS) 488-1000
Region II: Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, Puerto Rico, South Carolina, Tennessee, Virginia, Virgin Islands, and West Virginia	USNRC, 101 Marietta Street, Suite 3100, Atlanta, GA 30303	(404) 221-4503, (FTS) 242-4503
Region III: Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, and Wisconsin	USNRC, 799 Roosevelt Road, Glen Ellyn, IL 60137	(312) 932-2500, (FTS) 384-2500
Region IV: Arkansas, Colorado, Idaho, Kansas, Louisiana, Montana, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, Texas, Utah, and Wyoming	USNRC, 611 Ryan Plaza Drive, Suite 1000, Arlington, TX 76011	(817) 860-8100, (FTS) 728-8100
Region IV Field Office	USNRC, Region IV Uranium Recovery Field Office, 730 Simms Street, P.O. Box 25325, Denver, CO 80225	(303) 234-7232, (FTS) 234-7232
Region V: Alaska, Arizona, California, Hawaii, Nevada, Oregon, Washington, and U.S. territories and possessions in the Pacific	USNRC, 1450 Maria Lane, Suite 210, Walnut Creek, CA 94596	(415) 943-3700, (FTS) 463-3700

[47 FR 41338, Sept. 20, 1982]

PART 21—REPORTING OF DEFECTS AND NONCOMPLIANCE *

GENERAL PROVISIONS

AUTHORITY: Secs. 161i and 161o, Pub. L. 83-703, 68 Stat. 949 and 950, as amended, sec. 234, Pub. L. 91-161, 83 Stat. 444; secs. 201 and 206, Pub. L. 93-438, 88 Stat. 1242 and 1246, as amended (42 U.S.C. 2201(i), 2201(o), 2282, 5841, 5846).

SOURCE: 42 FR 28893, June 6, 1977, unless otherwise noted.

GENERAL PROVISIONS

§ 21.1 Purpose.

The regulations in this part establish procedures and requirements for implementation of section 206 of the Energy Reorganization Act of 1974. That section requires any individual director or responsible officer of a firm constructing, owning, operating or supplying the components of any facility or activity which is licensed or otherwise regulated pursuant to the Atomic Energy Act of 1954, as amended, or the Energy Reorganization Act of 1974, who obtains information reasonably indicating: (a) That the facility, activity or basic component supplied to such facility or activity fails to comply with the Atomic Energy Act of 1954, as amended, or any applicable rule, regulation, order, or license of the Commission relating to substantial safety hazards or (b) that the facility, activity, or basic component supplied to such facility or activity contains defects, which could create a substantial safety hazard, to immediately notify the Commission of such failure to comply or such defect, unless he has actual knowledge that the Commission has been adequately informed of such defect or failure to comply.

* Code of Federal Regulations, Title 10 - Energy, Parts 0 to 199, Revised as of January 1, 1983

§ 21.2 Scope.

The regulations in this part apply, except as specifically provided otherwise in Parts 31, 34, 35, 40, 60, 61, 70, or 72 of this chapter, to each individual, partnership, corporation, or other entity licensed pursuant to the regulations in this chapter to possess, use, and/or transfer within the United States source material, byproduct material, special nuclear material, and/or spent fuel, or to construct, manufacture, possess, own, operate and/or transfer within the United States, any production or utilization facility or independent spent fuel storage installation, and to each director (see § 21.3(f)) and responsible officer (see § 21.3(j)) of such a licensee. The regulations in this part apply also to each individual, corporation, partnership or other entity doing business within the United States, and each director and responsible officer of such organization, that constructs (see § 21.3(c)) a production or utilization facility licensed for manufacture, construction or operation (see § 21.3(h)) pursuant to Part 50 of this chapter or an independent spent fuel storage installation for the storage of spent fuel licensed pursuant to Part 72 of this chapter, or supplies (see § 21.3(l)) basic components (see § 21.3(a)) for a facility or activity licensed, other than for export, under Parts 30, 40, 50, 60, 70, 71, or 72 of this chapter. Nothing in these regulations should be deemed to preclude either an individual or a manufacturer/supplier of a commercial grade item (see § 21.3(a-1)) not subject to the regulations in this part from reporting to the Commission a known or suspected defect or failure to comply and, as authorized by law, the identity of anyone so reporting will be withheld from disclosure.[1]

[46 FR 58282, Dec. 1, 1981, as amended at 47 FR 41338, Sept. 20, 1982; 47 FR 57480, Dec. 27, 1982]

EFFECTIVE DATE NOTE: At 47 FR 57480, Dec. 27, 1982, § 21.2 was amended by inserting "61," after "40, 60,", effective January 26, 1983.

§ 21.3 Definitions.

As used in this part:

(a)(1) "Basic component," when applied to nuclear power reactors means a plant structure, system, component or part thereof necessary to assure (i) the integrity of the reactor coolant pressure boundary, (ii) the capability to shut down the reactor and maintain it in a safe shutdown condition, or (iii) the capability to prevent or mitigate the consequences of accidents which could result in potential offsite exposures comparable to those referred to in § 100.11 of this chapter.

(2) "Basic component," when applied to other facilities and when applied to other activities licensed pursuant to Parts 30, 40, 50, 60, 61, 70, 71, or 72 of this chapter, means a component, structure, system, or part thereof that is directly procured by the licensee of a facility or activity subject to the regulations in this part and in which a defect (see § 21.3(d)) or failure to comply with any applicable regulation in this chapter, order, or license issued by the Commission could create a substantial safety hazard (see § 21.3(k)).

(3) In all cases "basic component" includes design, inspection, testing, or consulting services important to safety that are associated with the component hardware, whether these services are performed by the component supplier or others.

(4) A commercial grade item is not a part of a basic component until after dedication (see § 21.3(c-1)).

(a-1) "Commercial grade item" means an item that is (1) not subject to design or specification requirements that are unique to facilities or activities licensed pursuant to Parts 30, 40, 50, 60, 61, 70, 71, or 72 of this chapter

[1] NRC Regional Offices will accept collect telephone calls from individuals who wish to speak to NRC representatives concerning nuclear safety-related problems. The location and telephone numbers (for night and holidays as well as regular hours) are listed below:

Region	
I (Philadelphia)	(215) 337-5000
II (Atlanta)	(404) 221-4503
III (Chicago)	(312) 932-2500
IV (Dallas)	(817) 860-8100
IV Uranium Recovery Field Office (Denver)	(303) 234-7232
V (San Francisco)	(415) 943-3700

and (2) used in applications other than facilities or activities licensed pursuant to Parts 30, 40, 50, 60, 61, 70, 71, or 72 of this chapter and (3) to be ordered from the manufacturer/supplier on the basis of specifications set forth in the manufacturer's published product description (for example a catalog).

(b) "Commission" means the Nuclear Regulatory Commission or its duly authorized representatives.

(c) "Constructing" or "construction" means the design, manufacture, fabrication, placement, erection, installation, modification, inspection, or testing of a facility or activity which is subject to the regulations in this part and consulting services related to the facility or activity that are important to safety.

(c-1) "Dedication" of a commercial grade item occurs after receipt when that item is designated for use as a basic component.

(d) "Defect" means:

(1) A deviation (see § 21.3(e)) in a basic component delivered to a purchaser for use in a facility or an activity subject to the regulations in this part if, on the basis of an evaluation (see § 21.3(g)), the deviation could create a substantial safety hazard; or

(2) The installation, use, or operation of a basic component containing a defect as defined in paragraph (d)(1) of this section; or

(3) A deviation in a portion of a facility subject to the construction permit or manufacturing licensing requirements of Part 50 of this chapter provided the deviation could, on the basis of an evaluation, create a substantial safety hazard and the portion of the facility containing the deviation has been offered to the purchaser for acceptance; or

(4) A condition or circumstance involving a basic component that could contribute to the exceeding of a safety limit, as defined in the technical specifications of a license for operation issued pursuant to Part 50 of this chapter.

(e) "Deviation" means a departure from the technical requirements included in a procurement document (see § 21.3(i)).

(f) "Director" means an individual, appointed or elected according to law, who is authorized to manage and direct the affairs of a corporation, partnership or other entity. In the case of an individual proprietorship, "director" means the individual.

(g) "Evaluation" means the process accomplished by or for a licensee to determine whether a particular deviation could create a substantial safety hazard.

(h) "Operating" or "operation" means the operation of a facility or the conduct of a licensed activity which is subject to the regulations in this part and consulting services related to operations that are important to safety.

(i) "Procurement document" means a contract that defines the requirements which facilities or basic components must meet in order to be considered acceptable by the purchaser.

(j) "Responsible officer" means the president, vice-president or other individual in the organization of a corporation, partnership, or other entity who is vested with executive authority over activities subject to this part.

(k) "Substantial safety hazard" means a loss of safety function to the extent that there is a major reduction in the degree of protection provided to public health and safety for any facility or activity licensed, other than for export, pursuant to Parts 30, 40, 50, 60, 61, 70, 71, or 72 of this chapter.

(l) "Supplying" or "supplies" means contractually responsible for a basic component used or to be used in a facility or activity which is subject to the regulations in this part.

[42 FR 28893, June 6, 1977; 42 FR 36803, July 18, 1977, as amended at 43 FR 48622, Oct. 19, 1978; 46 FR 58283, Dec. 1, 1981; 47 FR 57480, Dec. 27, 1982]

EFFECTIVE DATE NOTE: At 47 FR 57480, Dec. 27, 1982, § 21.3(a)(2), (a-1) (1) and (2), and (k) were amended by inserting "61," after "50, 60,", effective January 26, 1983.

§ 21.4 Interpretations.

Except as specifically authorized by the Commission in writing, no interpretation of the meaning of the regulations in this part by any officer or employee of the Commission other than a written interpretation by the

General Counsel will be recognized to be binding upon the Commission.

§ 21.5 Communications.

Except where otherwise specified in this part, all communications and reports concerning the regulations in this part should be addressed to the Director, Office of Inspection and Enforcement, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, or to the Director of a Regional Office at the address specified in Appendix D of Part 20 of this chapter. Communications and reports also may be delivered in person at the Commission's offices at 1717 H Street NW., Washington, D.C.; at 7920 Norfolk Avenue, Bethesda, Md.; or at a Regional Office at the location specified in Appendix D of Part 20 of this chapter.

§ 21.6 Posting requirements.

(a) Each individual, partnership, corporation or other entity subject to the regulations in this part, shall post current copies of the following documents in a conspicuous position on any premises, within the United States where the activities subject to this part are conducted (1) the regulations in this part, (2) section 206 of the Energy Reorganization Act of 1974, and (3) procedures adopted pursuant to the regulations in this part.

(b) If posting of the regulations in this part or the procedures adopted pursuant to the regulations in this part is not practicable, the licensee or firm subject to the regulations in this part may, in addition to posting section 206, post a notice which describes the regulations/procedures, including the name of the individual to whom reports may be made, and states where they may be examined.

(c) The effective date of this section has been deferred until January 6, 1978.

§ 21.7 Exemptions.

The Commission may, upon application of any interested person or upon its own initiative, grant such exemptions from the requirements of the regulations in this part as it determines are authorized by law and will not endanger life or property or the common defense and security and are otherwise in the public interest. Suppliers of commercial grade items are exempt from the provisions of this part to the extent that they supply commercial grade items.

[42 FR 28893, June 6, 1977, as amended at 43 FR 48622, Oct. 19, 1978]

NOTIFICATION

§ 21.21 Notification of failure to comply or existence of a defect.

(a) Each individual, corporation, partnership or other entity subject to the regulations in this part shall adopt appropriate procedures to:

(1) Provide for: (i) Evaluating deviations or (ii) informing the licensee or purchaser of the deviation in order that the licensee or purchaser may cause the deviation to be evaluated unless the deviation has been corrected; and

(2) Assure that a director or responsible officer is informed if the construction or operation of a facility, or activity, or a basic component supplied for such facility or activity:

(i) Fails to comply with the Atomic Energy Act of 1954, as amended, or any applicable rule, regulation, order or license of the Commission relating to a substantial safety hazard, or

(ii) Contains a defect. The effective date of this paragraph has been deferred until January 6, 1978.

(b)(1) A director or responsible officer subject to the regulations of this part or a designated person shall notify the Commission when he obtains information reasonably indicating a failure to comply or a defect affecting (i) the construction or operation of a facility or an activity within the United States that is subject to the licensing requirements under Parts 30, 40, 50, 60, 61, 70, 71, or 72 of this chapter and that is within his organization's responsibility or (ii) a basic component that is within his organization's responsibility and is supplied for a facility or an activity within the United States that is subject to the licensing requirements under Parts 30, 40, 50, 60, 61, 70, 71, or 72 of this chapter. The above notification is not required if such individual has actual knowledge that the Com-

mission has been adequately informed of such defect or such failure to comply.

(2) Initial notification required by this paragraph shall be made within two days following receipt of the information. Notification shall be made to the Director, Office of Inspection and Enforcement, or to the Director of a Regional Office. If initial notification is by means other than written communication, a written report shall be submitted to the appropriate Office within 5 days after the information is obtained. Three copies of each report shall be submitted to the Director, Office of Inspection and Enforcement.

(3) The written report required by this paragraph shall include, but need not be limited to, the following information, to the extent known:

(i) Name and address of the individual or individuals informing the Commission.

(ii) Identification of the facility, the activity, or the basic component supplied for such facility or such activity within the United States which fails to comply or contains a defect.

(iii) Identification of the firm constructing the facility or supplying the basic component which fails to comply or contains a defect.

(iv) Nature of the defect or failure to comply and the safety hazard which is created or could be created by such defect or failure to comply.

(v) The date on which the information of such defect or failure to comply was obtained.

(vi) In the case of a basic component which contains a defect or fails to comply, the number and location of all such components in use at, supplied for, or being supplied for one or more facilities or activities subject to the regulations in this part.

(vii) The corrective action which has been, is being, or will be taken; the name of the individual or organization responsible for the action; and the length of time that has been or will be taken to complete the action.

(viii) Any advice related to the defect or failure to comply about the facility, activity, or basic component that has been, is being, or will be given to purchasers or licensees.

(4) The director or responsible officer may authorize an individual to provide the notification required by this paragraph, provided that, this shall not relieve the director or responsible officer of his or her responsibility under this paragraph.

(c) Individuals subject to paragraph (b) of this section may be required by the Commission to supply additional information related to the defect or failure to comply.

[42 FR 28893, June 6, 1977, as amended at 46 FR 58283, Dec. 1, 1981; 47 FR 57480, Dec. 27, 1982]

EFFECTIVE DATE NOTE: At 47 FR 57480, Dec. 27, 1982, § 20.21(b)(1) (i) and (ii) were amended by inserting "61," after "50, 60,", effective January 26, 1983.

PROCUREMENT DOCUMENTS

§ 21.31 Procurement documents.

Each individual, corporation, partnership or other entity subject to the regulations in this part shall assure that each procurement document for a facility, or a basic component issued by him, her or it on or after January 6, 1978 specifies, when applicable, that the provisions of 10 CFR Part 21 apply.

INSPECTIONS, RECORDS

§ 21.41 Inspections.

Each individual, corporation, partnership or other entity subject to the regulations in this part shall permit duly authorized representatives of the Commission, to inspect its records, premises, activities, and basic components as necessary to effectuate the purposes of this part.

§ 21.51 Maintenance of records.

(a) Each licensee of a facility or activity subject to the regulations in this part shall maintain such records in connection with the licensed facility or activity as may be required to assure compliance with the regulations in this part.

(b) Each individual, corporation, partnership, or other entity subject to the regulations in this part shall prepare records in connection with the designs, manufacture, fabrication, placement, erection, installation,

modification, inspection, or testing of any facility, basic component supplied for any licensed facility or to be used in any licensed activity sufficient to assure compliance with the regulations in this part. After delivery of the facility or component and prior to the destruction of the records relating to evaluations (see § 21.3(g)) or notifications to the Commission (see § 21.21), such records shall be offered to the purchaser of the facility or component. If such purchaser determines any such records:

(1) Are not related to the creation of a substantial safety hazard, he may authorize such records to be destroyed, or

(2) Are related to the creation of a substantial safety hazard, he shall cause such records to be offered to the organization to which he supplies basic components or for which he constructs a facility or activity.

If such purchaser is unable to make the determination as required above then the responsibility for making the determination shall be transferred to the individual, corporation, partnership, or other entity subject to the regulations in this part that issued the procurement document to the purchaser. In the event that the determination cannot be made at that level then the responsibility shall be transferred in a similar manner to another individual, corporation, partnership, or other entity subject to the regulations in this part, until, if necessary, the licensee shall make the determination.

(c) Records that are prepared only for the purpose of assuring compliance with the regulations in this part and are not related to evaluations or notifications to the Commission may be destroyed after delivery of the facility or component.

(d) The effective date of the section has been deferred until January 6, 1978.

ENFORCEMENT

§ 21.61 Failure to notify.

Any director or responsible officer subject to the regulations in this part who knowingly and consciously fails to provide the notice required by § 21.21 shall be subject to a civil penalty equal to the amount provided by section 234 of the Atomic Energy Act of 1954, as amended.

[46 FR 13202, Feb. 20, 1981]

NOTE: The reporting and record keeping requirements contained in this part have been approved by the General Accounting Office under B-180225 (R0 446).

APPENDIX III

SECTION 206

ENERGY REORGANIZATION ACT OF 1974

ENERGY REORGANIZATION ACT OF 1974 *

Public Law 93-438

NONCOMPLIANCE

SEC. 206. (a) Any individual director, or responsible officer of a firm constructing, owning, operating, or supplying the components of any facility or activity which is licensed or otherwise regulated pursuant to the Atomic Energy Act of 1954 as amended, or pursuant to this Act, who obtains information reasonably indicating that such facility or activity or basic components supplied to such facility or activity—

(1) fails to comply with the Atomic Energy Act of 1954, as amended, or any applicable rule, regulation, order, or license of the Commission relating to substantial safety hazards, or

(2) contains a defect which could create a substantial safety hazard, as defined by regulations which the Commission shall promulgate,

shall immediately notify the Commission of such failure to comply, or of such defect, unless such person has actual knowledge that the Commission has been adequately informed of such defect or failure to comply.

(b) Any person who knowingly and consciously fails to provide the notice required by subsection (a) of this section shall be subject to a civil penalty in an amount equal to the amount provided by section 234 of the Atomic Energy Act of 1954, as amended.

(c) The requirements of this section shall be prominently posted on the premises of any facility licensed or otherwise regulated pursuant to the Atomic Energy Act of 1954, as amended.

(d) The Commission is authorized to conduct such reasonable inspections and other enforcement activities as needed to insure compliance with the provisions of this section.

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* Extracted from "Compilation of Selected Energy-Related Legislation - Volume III - Energy Conservation, Organization, and Related Matters." Prepared for the Use of the Committee on Energy and Commerce, U.S. House of Representatives, 97th Congress, 1st Session, Committee Print 97-H (May, 1981).

APPENDIX IV

BRIEF BIOGRAPHICAL SKETCHES OF KEY PERSONNEL

Technical biographical data on the key personnel in the organization of the RDI Reactor Component Qualification Program are presented. The following personnel have been included:

Dr. James N. Anno

Dr. Thomas J. Crawford

Dr. Terrence P. Toepker

Linda A. Rieser

Dennis A. Tierney

Johnnie J. Kelley

Dr. Monte J. Pool

Dr. Freeman F. Suagee

Howard H. Boeing II

Janet W. Anno

DR. JAMES N. ANNO

Primary Role in Program: Program Manager

Dr. Anno has had over 25 years of experience in research and development. Seventeen of these years were spent in government and industrial research at Battelle Memorial Institute, primarily in the nuclear field, and the remainder at University of Cincinnati where he has performed both in-house and contract research. In September, 1977, he formed Research Dynamics Incorporated. He has participated in electrical component qualification tests in a radiation environment in three previous programs: NADC Missile Program, Space Nuclear Power (SNAP), and the NASA/JPL Space Program. He currently teaches a course in Radiation Effects at University of Cincinnati. A summary of his background and experience is given below.

President, Research Dynamics Incorporated
Professor of Nuclear Engineering, University of Cincinnati

Education

Ph.D.	1965	The Ohio State University (Physics)
M.S.	1961	The Ohio State University (Physics)
B.S.	1955	The Ohio State University (Physics)

Professional and Society Affiliations

American Nuclear Society
American Nuclear Society - Southwest Ohio
American Physical Society
American Institute of Aeronautics and Astronautics
Sigma Xi
Phi Beta Kappa

Fields of Special Interest

Fluid Dynamics
Lubrication Mechanics
Engineering Aspects of Nuclear Radiations
Thermonuclear Fusion

Experience

1981-82 Head, Department of Chemical & Nuclear Engineering, University of Cincinnati

1977- President, Research Dynamics Incorporated

1970- University of Cincinnati
- 1973- Professor of Nuclear Engineering
  - Director, Laboratory of Basic and Applied Nuclear Research
  - Consultant, Battelle Memorial Institute
- 1970-73 Director, Laboratory of Basic and Applied Nuclear Research
  - Associate Professor of Nuclear Engineering

1953-70 Battelle Memorial Institute, Columbus Laboratories
- 1969-70 Research Fellow, Nuclear Engineering and Analysis Division
- 1967-69 Chief, Lubrication Mechanics Division
- 1965-67 Associate Chief, Structural Physics Division
- 1960-65 Associate Chief, Applied Nuclear Physics Divison
- 1955-60 Operating Supervisor, Battelle Research Reactor
- 1953-55 Research Technician

Recent Publications and Reviewed Papers
(* Denotes Refereed Journal)

Gamma Radiation-Induced Outgassing, submitted to Trans. AIChE (May, 1983), with T.P. Toepker.

* Radiation-Induced Outgassing from Sorption Pump Material, Nuclear Technology, 56, 401 (February, 1982), with V.N. Patel.

* Estimate of Human Control Over Mid-Air Collisions, AIAA Journal of Aircraft, 19, No. 1, 86-88 (January, 1982).

* Radiation-Induced Gas Evolution from Several Organic Liquids, Nuclear Technology, 52, 437-438 (March, 1981), with Woon H. Chung.

* Radiation-Induced Outgassing from Several Metals, Nuclear Technology, 52, 435-436 (March, 1981), with A.R. Shepherd.

* Gamma-Induced Electron Emission from Conducting Surface, Nuclear Technology, 52, 139-140 (January, 1981), with James D. Wolcott.

* Radiation-Induced Outgassing from Stainless Steel 304, Nuclear Technology, 46, 127-133 (November, 1979), with T.P. Toepker.

* Thermal Neutron Flux Depression in Cylindrical UO_2 Fuel Rods, Nuclear Technology, 45, 193 (September, 1979), with J.E. Gibson.

* Nuclear Processing of Radioactive Wastes, Cincinnati Engineer and Scientist, 2, No. 1, 14-16 (October, 1977).

* Secondary Electron Emission from 0.5-2.5 MeV Protons and Deuterons, Journal of Applied Physics, 48, 1718-1719 (April, 1977), with T.A. Thornton.

* Welding Plastics by the Neutron Capture Process, Nuclear Technology, 29, No. 1, 124-126 (April, 1976).

Skidding on a Wet Pavement, AIChE Student Member Bulletin, 14-17 (September, 1975).

* Hydrodynamic Film-Thickness Determinations in a Face Seal, Lubrication Engineering, 132-135 (March, 1975).

* Fast Neutron Sputtering of Iron at Various Temperatures, Journal of Nuclear Materials, 54, 79-84 (1974).

* Influence of Viscosity on the Stability of a Cylindrical Jet, AIAA Journal, 12, No. 8, 1137-1138 (August, 1974).

* Thermal Spike Model with Temperature-Dependent Specific Heat, ASME Journal of Heat Transfer, Technical Note 73-S-113 TB, (1973), with Kalimullah.

* Sputtering of Iron by Fast Neutrons, Journal of Applied Physics, 43, 2453-2454 (May, 1972), with T.S. Baer.

* Pumping of Mercury Drops by a Travelling Electrical Potential Wave, AIChE Journal, 18, 234-235 (January, 1972), with R. Holmes.

* Analysis of Corrosion of Stainless Steel in a Sodium and High Radiation Environment, Nuclear Technology, 10, 67 (January, 1971), with J.A. Walowit.

* Integral Form of the Derivation of Rayleigh's Criterion for the Instability of an Inviscid Cylindrical Jet, American Journal of Physics, 38, 1255 (1970), with J.A. Walowit.

* Influence of Shear Heating on the Motion of an Electrically-Stressed Thin Di-electric Fluid Film, Journal of Applied Physics, 41, 2258 (1970), with J.A. Walowit.

* Load Support and Leakage from Microasperity-Lubricated Face Seals, Journal of Lubrication Technology (October, 1969), with J.A. Walowit and C.M. Allen.

* ac Breakdown Voltage for a Thin Dielectric Fluid Film, Journal of Applied Physics, 39, 4326-4328 (August, 1968).

Study of Cathodic Cleaning with the Plasma Arc Welding Journal, 47, No. 4, 181-s (April, 1968), with H.E. Pattee and M.D. Randall.

* Microasperity Lubrication, Journal of Lubrication Technology, 90, Series F, No. 2, 351-355 (April, 1968), with J.A. Walowit and C.M. Allen.

* Factors Influencing the Effects of Reactor Radiations on Electrical Components, Nuclear Applications, 2, 371 (October, 1966).

* Secondary Electron Production from Approximately 1-Mev Alpha Particles Emerging from Gold, Journal of Applied Physics (Communication), 37, 2929 (1966), with L.L. Yarger.

* Sputtering of Polycrystalline Gold by Fast Neutrons, Journal of Applied Physics, 37, 621 (1966), with D.W. Norcross and B.F. Fairand.

* Comparison of Secondary Electron Yield from Fission Fragments Emerging from and Impinging upon a Thin Layer of Uranium Dioxide, Journal of Applied Physics, 26, 3949 (December, 1965), with R.C. Jung.

* Secondary Electron Production from Alpha Particles Emerging from Gold, Journal of Applied Physics, 34, No. 12, 3495-3499 (December, 1963).

* Fission Plate Power Measurement by a Transient Temperature Method, Nuclear Science and Engineering, 16, No. 4 (August, 1963).

A Direct-Energy Conversion Device using Alpha Particles, Nuclear News, 5, No. 12 (December, 1962).

* The Energy Spectrum of Fission Fragments Emitted from Thin Layers of Uranium Dioxide, Journal of Applied Physics, 33, (November, 1962), Letter-to-the-Editor, with R.W. Klingensmith and R.F. Redmond.

The Triode Concept of Direct Conversion, Battelle Technical Review, 3-9 (October, 1962), with S.L. Fawcett.

A New Concept for Direct Conversion, Southwestern Ohio Section, American Nuclear Society, Proceedings, Vol. 1, 13-19 (September, 1962).

* Secondary Electron Production from Fission Fragments Emerging from Thin Layers of Uranium Dioxide, Journal of Applied Physics, 33, No. 5, 1678-1681 (May, 1962).

The Battelle Research Reactor, Research Reactor Journal, 2, No. 2 (January, 1962), with A.M. Plummer.

A Modified Pile Oscillator for Thermal Neutron Cross-Section Measurements, Research Reactor Journal, 1, No. 4 (July, 1961).

Technical Meeting Papers:

Gamma Radiation-Induced Outgassing (GRIO), American Institute of Chemical Engineering, 1983 Annual Meeting, October 30-November 4, 1983, Washington, D.C., Paper No. 52 F, with T.P. Toepker.

Production of Porous Lithium Oxide, American Ceramic Society Conference, Nuclear Division, Cincinnati, Ohio (May 2, 1982), with H.H. Boeing.

An Electrofluid-Dynamic Cooling System Concept for Spacecraft Environmental Control, ASME Space Technology and Heat Transfer Conference, Los Angeles, California (June, 1970), with R.E. Holmes.

Load Support and Leakage from Microasperity Lubrication, Third International Conference on Fluid Sealing, Philadelphia, Pennsylvania (May, 1969), with J.A. Walowit and C.M. Allen.

Microasperity Lubrication, Third International Conference on Fluid Sealing, Cambridge, England (April, 1967), with J.A. Walowit and C.M. Allen.

Theoretical and Experimental Study of Cathodic Cleaning with Plasma Arc, with H.E. Pattee and M.D. Randall. Presented at American Welding Society National Fall Meeting, San Francisco (October, 1964).

Conversion of Alpha Particle Kinetic Energy into Electricity, with A.M. Plummer, ANL-6802, 170-180 (December Paper presented at AMU-ANL Conference on Direct Energy Conversion, November 4-5, 1963).

Battelle Studies on the Triode Concept of Direct Energy Conversion, with A.M. Plummer. Presented at the Summer Institute on Direct Conversion at the University of Illinois (July 2, 1963).

Research Reactor Services. Presented at the First Annual Meeting of the Institute of Nuclear Materials Management (June 21-22, 1960).

Operation and Experimental Use of the Battelle Research Reactor, with A.M. Plummer and J.W. Chastain. Paper No. 27 presented at the Nuclear Engineering and Science Conference at New York, N.Y. (April, 1960).

A Modified Pile Oscillator for Thermal Neutron Absorption Cross-Section Measurements, with R.G. Jung and J.W. Chastain. ANS paper presented in Los Angeles, California (June, 1958).

Experience with a 1-Megawatt Pool-Type Research Reactor, with A.M. Plummer and J.W. Chastain. Presented at the 1958 Geneva Conference (April, 1958).

Experiments with the Battelle Research Reactor, with J.W. Chastain. ANS paper presented at the Meeting in Washington, D.C. (December, 1956).

Experimental Temperature Distributions in Fueled and Nonfueled Plates in the Bulk Shielding Reactor, with K.M. Henry. ANS paper presented at the Meeting in Chicago, Illinois (June, 1956).

Secondary Electron Production from Alpha Particles and Fission Fragments, Dissertation, The Ohio State University (1965).

Books

1. Nuclear Reactor Thermal Sciences, Dan Duncan and J.N. Anno (in preparation).

2. Notes on Radiation Effects, J.N. Anno, Hemisphere Publishing Co., 1983, (in publication).

3. The Mechanics of Liquid Jets, J.N. Anno, Lexington Books, D.C. Heath and Co., Lexington, Massachusetts, 1977.

4. Wave Mechanics for Engineers, J.N. Anno, Lexington Books, D.C. Heath and Co., Lexington, Massachusetts, 1976.

5. Modern Developments in Lubrication Mechanics, J.N. Anno and J.A. Walowit, Applied Science Publishers Ltd., London, 1975.

6. An Encyclopedia of Draw Poker, J.N. Anno, Exposition Press, New York, 1973.

Contributing Author To:

7. Elements of Nuclear Reactor Design, Elsevier Scientific Publishing Co., New York, 1977 (Editor: J. Weisman).

8. U.S. Research Reactor Operation, Maintenance and Use, Atomic Energy Series presented at the Second International Conference on the Peaceful Uses of Atomic Energy, Geneva, 1958 (Editor: J.W. Chastain).

Patents

Co-author of four U.S. patents on a novel heat engine, Nos. 3,859,789 (January 14, 1975), 3,938,337 (February 17, 1976), 4,117,696 (October 3, 1978), 4,197,715 (April 15, 1980), "Apparatus for Converting One Form of Energy into Another Form of Energy."

Co-inventor of a U.S. patent on a fusion reactor material, No. 4,221,775 (September 9, 1980), "Method of Producing Porous Lithium Oxide."

Book Reviews

Radiation Heat Transfer Notes, D.K. Edwards, Hemisphere Publishing Corporation (1981), Nuclear Technology, 61, 551 (June, 1983).

Ion Chambers for Neutron Dosimetry (Radiation Protection), J.J. Broerse, Harwood Academic Publishers, New York (1980), Nuclear Technology, 57, 445 (June, 1982).

Modern Physics, Robert L. Sproull and W. Andrew Phillips, John Wiley & Sons, Inc., New Jersey (1980), Nuclear Technology, 55, 731-732 (December, 1981).

Innovations in Energy: The Story of Kerr-McGee, John Samuel Ezell, The University of Oklahoma Press (1979), Nuclear Technology, 53, 87 (April, 1981).

Directorship

Chairman, Board of Directors, Research Dynamics Incorporated

DR. THOMAS J. CRAWFORD

Primary Role in Program: Senior Test Engineer

Dr. Crawford's principal duties are the preparation and implementation of Test Plans needed for the qualification of Class 1E electrical components used in nuclear power plants. He brings to the project nuclear fuel management experience from Philadelphia Electric Company, and testing experience from Procter & Gamble and from independent thesis research. A summary of his background and experience is given below:

Education

Drexel University, PhD 1983, MSME 1981 (G.P.A. 3.89-4.0)
Dissertation: "Analysis of Steady-State and Transient Two-Phase Flows in Downwardly Inclined Lines."

University of Cincinnati, MSNE 1978 (G.P.A. 3.55-4.0), BSChE 1975 (G.P.A. 3.51-4.0) Honors: Mu Pi Kappa
Thesis: "An Experimental Study of Horizontal Two-Phase Flow Patterns in the Freon-113 System."

Professional Development Training. Have completed the Dale Carnegie Course in "Effective Speaking and Human Relations," and have served as a graduate assistant in that course.

Registration

Registered Professional Engineer, State of Ohio, 1984

Fields of Special Interest

Thermalhydraulics
Nuclear Fuel Management
Fuel Design
Reactor Operation

Experience

1983- Research Dynamics Incorporated, Cincinnati, Ohio
Senior Test Engineer. Responsible for managing activities of testing laboratory for contract research and testing company. Write test plans, procedures, and reports for testing and qualification of safety-related equipment used in nuclear power plants or commercial grade items with common industrial application. Responsible for preparation of company capability statement. Write proposals for new research work. Direct activities of assistant engineers, technicians, and a computer programmer.

1979-82 Tutoring of undergraduates in calculus, physics, and engineering courses at Philadelphia Electric Company. Teaching assistant work for Professional Development and undergraduate courses in nuclear engineering offered by the University of Cincinnati.

1978-81 Philadelphia Electric Company, Philadelphia, Pennsylvania
Nuclear Fuel Management Engineer. Responsible for nuclear core analysis efforts and fuel fabrication contract and related warranty settlements in support of Peach Bottom Atomic Power Station. Maintained computer code used in core following and predictive calculations. Also involved in shielding calculations and installation of High Density Spent Fuel Racks and assisted in directing activities of two other core analysis engineers.

1979-80 Neutronics Inc., Haddonfield, New Jersey
Vice President and Treasurer for small nuclear engineering, manufacturing, and consulting firm. Corporation specialized in the design, licensing, and manufacture of the neutron poison test device for spent fuel racks.

1977-78 Knolls Atomic Power Laboratory, Schenectady, New York
Operations Engineer-in-Training at Nuclear Power Engineering School in preparation for assignment at training site as Plant Engineer and Nuclear Navy Instructor.

1973-76 Procter & Gamble, Cincinnati, Ohio
Packaging Technician. Involved with new product packaging design and developments. Performed routine laboratory testing on various packaging components. Assisted in writing packing material specifications for buyers and suppliers, and packing instructions for use in P&G manufacturing plants. Worked with various P&G departments and suppliers in qualification of cartons, wrappers, and containers.

Publications

Crawford, T.J. and Weisman, J., "Two-Phase Flow Pattern Transitions in Ducts of Non-Circular Cross Sections and Under Diabatic Conditions," to be published (1984).

Weisman, J., Duncan, D., Gibson, J., and Crawford, T.J., "Effects of Liquid Properties and Pipe Diameter on Two-Phase Flow Patterns in Horizontal Lines," Int. J. of Multiphase Flow, V5, pp. 436-462, Pergamon Press (1979).

Patent

U.S. Patent #4,277,680, "Neutron Poison Test Device for High Density Spent Fuel Storage Racks."

Professional Development

Equipment Qualification Program
Chicago, Illinois
June, 1983

DR. TERRENCE P. TOEPKER

Primary Role in Program: Senior Research Engineer

Dr. Toepker brought to the project over 20 years of experience in personnel supervision and laboratory equipment operation and management. As a Professor of Physics at Xavier University, he has taught numerous laboratory courses, including Nuclear Instrumentation. He performed his Ph.D. dissertation research using the University of Cincinnati cobalt-60 source. He has been Project Manager on grants from the Department of Energy, National Science Foundation, Greater Cincinnati Foundation, and Schmidlapp Foundation. A brief description of Dr. Toepker's background and experience follows.

Education

Ph.D.	1978	University of Cincinnati (Nuclear Engineering)
M.S.	1968	Xavier University (Physics)
M.Ed.	1964	Xavier University (Physics Education)
B.S.	1961	Xavier University (Physics)

Professional and Society Affilitations

American Association of Physics Teachers
American Nuclear Society
American Physical Society
American Society for Testing and Materials

Fields of Specialization and Interest

Energy Production and Conversion
Nuclear Physics (Director of Nuclear Laboratory, 1972-present)
Holography (Laser Photography, Stress Analysis)
Science Education

Experience

1983- Xavier University
Chairman, Department of Physics

1982- Research Dynamics Incorporated

6/1/83-	Consultant and Senior Test Engineer (Part Time)
6/1/82-5/31/83	Senior Test Engineer (Full Time)
1/1/82-5/31/82	Consultant (Part Time)

1966-82 Xavier University

1978-82	Chairman, Physics Department
1981-	Professor of Physics
1978-81	Associate Professor
1969-78	Assistant Professor
1966-69	Physics Instructor

1961-66 St. Xavier High School
Physics and Mathematics Instructor

As Senior Test Engineer for Research Dynamics Incorporated on a project for The Cincinnati Gas & Electric Company, he has:

1. Supervised and coordinated efforts of technical personnel.
2. Acted as liaison between CG&E and RDI.
3. Coordinated subcontract work with University of Cincinnati personnel (radiation testing).
4. Coordinated subcontract work with Farwell & Hendricks, Inc. (F&H) [formerly Structural Dynamics Research Corp.] (seismic testing).
5. Prepared Qualification Plans for test specimens which were selected by CG&E.
6. Cooperated in the planning and construction of the testing laboratory facilities in 402 Old Chemistry Building, University of Cincinnati.

Published Articles and Notes

"Are You Being Radiated," The Physics Teacher (April 23, 1980)

"Holo Egg," The Physics Teacher (April, 1980).

"Radiation Induced Outgassing from Type 304 Stainless Steel," Nuclear Technology, Vol. 46 (November, 1979).

"More Center of Gravity," The Physics Teacher (November, 1976).

"Angular Momentum Anomalies," 5-minute film, 3rd Prize, national competition of the American Association of Physics Teachers (January, 1972).

"A Problem with Pulleys," Science Teachers' Workshop (December, 1969).

"Sound on a Light Beam," The Physics Teacher (May, 1969).

"An Inexpensive Holography Table," American Journal of Physics (April, 1969).

"I.C.B.M. - A Student Problem," Science Teachers' Workshop (February, 1969).

"Galileo Revisited," The Physics Teacher (February, 1968).

"Conservation of Momentum and Energy," The Physics Teacher (January, 1966).

Professional Development

Dr. Toepker has participated in a large number of conferences, workshops, and classroom courses, as indicated below, which demonstrates his span of abilities.

1. Equipment Qualification Program (EPRI)
   Washington, DC
   April, 1983

2. Oak Ridge National Laboratory Conference by Department of Energy and Union Carbide Corp.
   March 21-23, 1983

3. Oak Ridge Chamber of Commerce Presentation
   Oak Ridge, TN
   December 13, 1982

4. The Engineer as Manager
   Battelle Seminars and Studies Program
   October 21-22, 1982

5. Seismic Seminar
   Structural Dynamics Research Corporation
   May 19, 1982

6. Solar Energy (E-44, A.S.T.M.)
San Diego, CA
May 9-14, 1981

7. X-Ray Fluorescence, Activation Analysis
Oak Ridge National Laboratory
April 22-25, 1981

8. American Society for Testing and Materials (A.S.T.M.)
Faculty Program, Philadelphia, PA
January 5-7, 1981

9. Personalities of Modern Physics
N.S.F. Program at Dayton University
November, 1980

10. Fusion Energy
Argonne National Laboratory
June 7-11, 1976

11. Thermodynamics and Environment
N.S.F. Program at Miami University
November 4-5, 1974

12. Atmospheric Science
N.S.F. Program at Miami University
February 25-26, 1974

13. Holography
N.S.F. Program at Miami University
November 2-3, 1972

14. Ecological Implications of Ionizing Radiation
N.S.F. Program at Miami University
November 29-30, 1971

15. Mossbauer Spectroscopy
Argonne National Laboratory
April 23-24, 1971

16. Laser Safety Course
University of Cincinnati
August, 1970

17. Neutron Diffraction, Time of Flight of Neutrons, Approach to Critical Reactor
    Argonne National Laboratory
    February 26-27, 1970

18. Ultraviolet and Visible Spectroscopy
    Argonne National Laboratory
    November 14-15, 1969

19. X-Ray Diffraction Workshop
    Argonne National Laboratory
    October 31 - November 1, 1969

20. Nuclear Radiation Detection
    Argonne National Laboratory
    June 3-14, 1969

21. Changing Picture in Physics
    Battelle Memorial Institute
    March, 1969

Dr. Toepker has taught the following courses at Xavier University:

Ph 104	College Physics I
Ph 106	College Physics II
Ph 105	College Physics Lab. I
Ph 107	College Physics Lab. II
Ph 108	University Physics I
Ph 110	University Physics II
Ph 109	University Physics Lab. I
Ph 111	University Physics Lab. II
Ph 114	Intro. to Physical Sciences
Ph 115	Intro. to Physical Science Lab.
Ph 117	Earth Laboratory
Ph 154	Basic Mechanics
Ph 155	Basic Optics
Ph 352	Electromagnetism
Ph 365	Optics Laboratory

Ph 366	Atomic Physics
Ph 372	Advanced Electromagnetic Theory
Ph 374	Nuclear Physics
Ph 375	Atomic Physics Lab.
Ph 376	Quantum Mechanics
Ph 381	Nuclear Physics Lab.
Ph 378	Senior Seminar I
Ph 384	Senior Seminar II
Ph 397	Special Readings
Ph 410	Hands on Developmental Science

LINDA A. RIESER

Primary Role in Program: Assistant Project Engineer

Ms. Rieser brings to the project a unique combination of major project technical skills and purchasing and expediting knowledge on key equipment and components. She has approximately 10 years of industrial and university research experience. A summary of Ms. Rieser's education and experience is given below.

Education

1979-80 Phoenix College, Phoenix, Arizona
Geology, Chemistry

1976-78 Glendale College, Glendale, Arizona
Chemistry, Sociology

1974-75 Bio Systems, Phoenix, Arizona
Respiratory Therapy

1970-71 Ohio State University, Columbus, Ohio
Physical Sciences

1966-70 Franklin Heights High School, Columbus, Ohio

Experience

1983- Assistant Project Engineer, Research Dynamics Incorporated

Design, construction, and operation of pilot scale chemical process and materials test facilities.

1982 Junior Research Associate, The University of Cincinnati, Chemical and Nuclear Engineering Department

Engineering design and construction of test facilities for qualification of Class 1E electrical components for use in nuclear power plants.

1982 Purchasing Consultant, Research Dynamics Incorporated

Compiled cost projections, monitored project spending and provided technical assistance in selection and purchase of laboratory and industrial process equipment for use in nuclear component qualification.

1980-81 Research Technician, Battelle Memorial Institute

Worked on various projects in Industrial Chemical Engineering. Major project efforts include the following:

Forest Residue Gasification Project
Initial construction including piping, plumbing, wiring, control instrumentation, stack sampling, and analysis.

Ten-Inch Multi-Solid Fluidized Bed Combustor (MSFBC)
Initial construction including piping, plumbing, wiring, control instrumentation, control panel operator, major modifications technician.

Six-Inch MSFBC Program
Major modifications design technician, process operator. Drafted technical drawings, ordered all building materials and instrumentation for major rebuild.

Resistance Heated Fluidized Bed for Pyrolisis of Polychlorinated BiPhenyls (PCB's)
Lead technician for initial design, construction, and operation.

Twenty-Four-Inch FBC
Major modification engineering and design technician, lead process operator. Data reduction (heat transfer), stack sampling, technical drawings, selection and ordering of parts for 2 million/year project.

1977-79 Earth Sciences Inc.

Bench work in chemical analysis and processing of precious metals (gold, silver, platinum), engineering design and construction of custom milling facilities, field sampling to determine mining feasibility of individual claims or geographic regions.

1974-77 Technician, Stillion Distillers

Laboratory and pilot scale research into use of fuel grade ethanol for diesel engines.

DENNIS A. TIERNEY

Primary Role in Program: Assistant Project Engineer

Mr. Tierney brings to the project 10 years of experience as Technician in Industrial Research at Battelle Memorial Institute. Particularly pertinent is his experience in boiler operation (for the environmental chamber tests), radiation surveying, and instrumentation. He is intimately familiar with large project operation on an urgent time scale. A summary of Mr. Tierney's background and experience is given below.

Education

Graduate of DeSales High School, Columbus, Ohio, 1971

Experience

1982- Research Dynamics Incorporated
Assistant Project Engineer, Project Technician.

1971-81 Battelle Memorial Institute
Project Technician. Worked on various projects from photographic to large fluidized bed systems. The larger project efforts are as follows:

6" Multi-Solid Fluidized Bed Combustor
Construction, modification, materials preparation, and operation of A F B units. Credited with initial design and development of Distributed Air Transport Valve and Horizontal Plug Valve in use on 6" and 10" M S G B C units.

P D U Pressurized Coal Gasification Project (24-ton/day unit)
Design engineering, construction, in charge of utilities operation (stack burner, steam superheater, air compressors, boiler water treatment system, boiler, cooling water system, inert gas generator), panel board operator, and shift leader.

Radiation Survey
Field sampling of buildings, drilling of shallow wells for ground water and soil samples, photographs, drawings of maps to show areas above background radiation readings.

Forest Residue Gasification Project
Initial construction, including pipe fitting, plumbing, welding, wiring, and instrumentations.

10" Multi-Solid Fluidized Bed Combustion Unit (A F B)
Initial construction, including welding, pipe fitting, plumbing, wiring, and instrumentation, major modification and shift leader.

24" Fluidized Bed System
Major modifications technician and operations shift leader.

JOHNNIE J. KELLEY

Primary Role in Program: Test Technician

Mr. Kelley brings to the project over 20 years of experience in construction, repair, maintenance, and operation of mechanical and electrical equipment. With previous industrial experience in areas ranging from bearings to other automotive components, he adds expertise in the operation of both the testing facilities and the testing of the Class 1E safety-related components. A summary of his work experience, education, and military service follows.

Experience

1983- Research Dynamics Incorporated
Test Technician

1978-82 Psycle Therapy, Columbus, Ohio
Service Manager. Supervised all personnel related to company services (repair and maintenance of Japanese and European motorcycles). Implemented journeyman mechanic training program. Responsible for research and development of special purpose vehicles, i.e., race and tour motorcycles.

1971-78 Rusk Brothers Inc., Columbus, Ohio
Mechanic. Responsible for mechanical and electrical reconstruction of foreign and domestic automobiles. Repair and maintenance of air conditioner and cooling systems. Construction and assembly of towing vehicles, auto and truck.

1970-71 German Motor Car Co., Inc., Fort Collins, Colorado
Mechanic. Analyzed emission and endurance test results for BMW 2000. Responsible for repairs and preventive maintenance for German, Italian, and Swedish cars.

1969-70 Rusk Brothers Inc., Columbus, Ohio
Mechanic. See above

1969 George Bryers & Sons, Columbus, Ohio
Mechanic. Modification, assembly, and fabrication of English and French cars.

1969 Midwestern Volkswagen, Columbus, Ohio
Apprentice Mechanic. Repair and maintenance of VW's.

1967-68 Timken Roller Bearing, Columbus, Ohio
Tool Setter. Set-up of carbide tooling for multi-head screw machine, i.e., cut-off, breakdown, radius and champher tools.

1961-64 Timken Roller Bearing, Columbus, Ohio
Tool Setter. See above.

Education

1978 Eastland Vocational, Columbus, Ohio
Welding (including Gas, Tig, Mig, and Arc)

1978 International Correspondence Schools
Late-model Auto Repair and Maintenance

1968 Ohio State University, Columbus, Ohio
Liberal Arts

Military

1964-67 U.S. Air Force
Fuel Specialist. Maintenance and construction of fuel distribution systems (mobile and stationery) including AC and DC electrical switching apparatus, gear reduction and deep-well pumps. Honorable discharge as Buck Sergeant (E4). Top Secret Clearance (1965).

DR. MONTE J. POOL

Primary Role in Program: Quality Assurance Officer

Dr. Pool, Consultant to RDI, has been involved in the design, construction and application of high-temperature liquid-metal solution calorimeters for more than 20 years. This has included design of suitable vacuum systems for operation in the temperature region of 1300 to 1500 K at pressures of 10^{-6} to 10^{-7} torr. In addition, differential thermocouple systems capable of measuring temperature differences of less than 0.01 K were designed, constructed, and utilized in the same temperature region. Dr. Pool has also been actively involved in development of undergraduate metallurgical engineering laboratories during the past 15 years. This work has included design of meaningful experimental techniques and verification of the validity of his background and experience is given below.

Professor of Metallurgical Engineering

Education

Ph.D.	1961	Ohio State University
M.S.	1959	Ohio State University
Met. E.	1958	University of Cincinnati

Professional and Society Affiliations

American Society for Metals
(Member of Executive Committee, Cincinnati Chapter ASM - 1969/71, 1979/82)
(Secretary, Cincinnati Chapter ASM - 1971/72)
(Vice Chairman, Cincinnati Chapter ASM - 1972/73)
(Chairman, Cincinnati Chapter ASM - 1973/74)
AIME
(Chairman Pyromet. Comm. - 1970/71)
(Member Pyromet. Comm. - 1969/70, 70/71, 71/72)
American Association for the Advancement of Science

American Institute of Mining, Metallurgical and Petroleum Engineers
Tau Beta Pi
Sigma Xi
Phi Lamda Upsilon
Alpha Chi Sigma
Alpha Sigma Mu

Experience

1973-	University of Cincinnati, Professor
1968-73	University of Cincinnati, Associate Professor
1967-68	University of Denver, Associate Professor
1961-67	University of Denver, Assistant Professor

Fields of Special Interest

Thermodynamics of Metallic Solutions
Alloy Theory
Diffusion
Oxidation
Computer Analysis of Thermodynamic Systems

Teaching Awards

Recognized by the Engineering Tribunal and Tau Beta Pi for teaching excellence, 1971 and 1974

Industrial Participation

Consultant, International Nickel Co., Huntington, W. Va., June 1971 - Dec. 1971
Consultant, Cincinnati, Inc., Cincinnati, Ohio
NSF Industrial Research Participant, Globe-Union Inc., Milwaukee, WI, June-Sept. 1974
Visiting Researcher, Max Planck Inst., for Metallforschung, Stuttgart, Germany
Senior U.S. Scientist, Alexander von Humboldt Foundation

Publications and Papers

(with I. Arpshofen, U. Gerling, F. Sommer, E. Schultheiss and B. Predel), "Experimentalle Bestimmung der intergralen Mischungsenthalpien in den binaren Systemen Pd-Cu und Si-Cu bei 1600K," Z. Metallkunde, Vol. 72, 1981, p. 845.

(with I. Arpshofen, U. Gerling, F. Sommer, E. Schultheiss and B. Predel), "Bestimmung der Mischungsenthalpien im System Pallidium-Silicium bei 1600K," Z. Metallkunde, Vol. 72, 1981, p. 776.

(with A. Prakash), "Effect of impurities (graphite) on the High-Temperature Creep Properties of NiAl," J. Matls. Sci., Vol. 16, 1981, p. 2495.

(with B. Predel and E. Schultheiss), "Application of the SETARAM High-Temperature Calorimeter for Determination of Mixing Enthalpies of Liquid Alloys," Thermochimica Acta, Vol. 28, 1979, p. 349.

(with U. Gerling and B. Predel), "Zur Kenntnis thermodynamisher Eigenschaften flussiger Silber-Zink-Legierungen," Z. Metallkunde, Vol. 70, 1979, p. 224.

(with I. Arpshofen, B. Predel, and E. Schultheiss), "Ermittlung von Mischungsenthalpien Flussiger Legierungen des Systems Kupfer-Nicekl-Zinn mit einem SETARAM-hock-Temperatur-Kalorimeter," Z. Metallkunde, Vol. 70, 1979, p. 656.

(with I. Arpshofen, B. Predel, and E. Schultheiss), "Berechnung und Analyse der Mischungsenthalpien Flussiger Cu-Ni-Sn-Legierungen aufgrund verschiedener Modelle," Z. Metallkunde, Vol. 70, 1979, p. 726.

(with B. Predel), "Model Analysis of Mixing Enthalies in the Cd-To-In Ternary System," Thermochimica Acta, Vol. 27, 1978, p. 233.

(with B. Predel and I. Arpshofen), "Calorimetric Methods in Metallurgy," Thermochimica Acta, Vol. 22, 1978, p. 211.

(with B. Predel and J. Piehl), "Thermodynamische Aktivitaten Flussiger Palladium-Tellur Legierungen," Z. Metallkunde, Vol. 69, 1978, p. 293.

(with B. Predel and J. Piehl), "Schmelzenthalpien and Molwarmen Einiger Intermetallischer Verbindungen des Teilurs," Z. Metallkunde, Vol. 69, p. 405 (1978).

Thermodynaische Untersuchungen an binaren flussigen Legierungen des Tellurs mit Gallium, Indium and Tahllium, Z. Metallkunde, 66, No. 5, 268 (1975).

Beitrag zur Kenntnis der thermodynamischen Eigenschafter flussiger binarer Legierungen des Tellurs mit Zinn, Z. Metallkunde, 66, No. 6, 347 (1975).

Beitrag zur Kenntnis der Thermodynamischen Eigenschaften Flussiger Thallium-Selen, Wismut-Selen und Antimon-Selen Legierungen, Z. Metallkunde, 66, No. 7, 388 (1975).

Partial Heats of Mixing in the Bismuth-Tin System, Met. Trans., 3, 1773 (1972).

Thermodynamic Modeling of Binary and Ternary Metallic Systems, Met. Trans., 2, 3039 (1971).

Thermodynamic Investigation of the Ag-Mn System, Met. Trans., 2, 1029 (1971).

Thermodynamic Investigation of Liquid Ca-Sn, Sr-Sn, and Ba-Sn Alloys, Met. Trans., 1, 1779 (1970).

Thermodynamic Analysis of Dilute Ternary Systems. III. The Au-Cu-Sn System, Trans. TMS-AIME, 245, 603 (1969).

The Chemical Activities of Chromium and Molybdenum in Solid Chromium-Molybdenum Alloys, Trans. TMS-AIME, 245, 175 (1969).

Thermodynamic Properties of Cu-Mn Alloys, Trans. TMS-AIME, 245, 91 (1969).

Heats of Solution and Heats of Compound Formation in the Lanthanum-Tin System, Trans. TMS-AIME, 242, 2013 (1968).

A Calorimetric Study of the Rhodium-Tin System, Trans. TMS-AIME, 242, 1553 (1968).

Heats of Solution of Tellurium in Liquid Tin, Trans. TMS-AIME, 242, 1481 (1968).

Investigation of Liquid Palladium-Tin Alloys, J. Phys. Chem., 72, 2535 (1968).

Thermodynamic Analysis of Dilute Ternary Systems: I. The Ag-Au-Sn System, Trans. TMS-AIME, 242, 291 (1968).

Activities of Chromium and Titanium in Binary Chromium-Titanium Alloys, Trans. TMS-AIME, 239, 1180 (1967).

Heat Contents and Heats of Fusion of III-V Compounds, J. Chem. and Eng. Data, 12, 247 (1967).

Calorimetric Investigation of Silver, Cadium, and Zinc Tellurides, Trans. AIME, 233, 1711 (1965).

Heats of Mixing in Pr-Nd Solid Solutions, J. Less-Common Metals, 9, 48 (1965).

Heats of Solution of P, As, and Sb in Liquid Tin at 750°K, Trans. AIME, 233, 1439 (1965).

Heats of Solution of Pr, Nd, and Sm in Liquid Tin, Proceedings of the Fourth Conference on Rare Earth Research, Gordon and Breach, New York, 1965, p. 269.

Heats of Solution of Al, Ga, and In in Liquid Tin at 750°K, Trans. AIME, 230, 589 (1964).

The Tungsten-Oxygen System, Trans. AIME, 224, 259 (1962).

DR. FREEMAN F. SUAGEE

Primary Role in Program: Corporate Vice President, General Manager, and Purchasing Controller

Dr. Suagee, Consultant to RDI, has had over 35 years of experience in personnel, management, labor arbitrations, and administrative work. He is also a member of the Board of Directors of RDI since its founding in 1977. He is expert in negotiating contracts and agreements with organizations. Dr. Suagee has been a member of the faculty of the University of Cincinnati since 1948 and is a professor of economics. A summary of his background and experience is given below.

Education

Ph.D.	1948	University of Wisconsin (Economics)
M.A.	1946	University of Wisconsin (Economics)
A.B.	1943	University of Oklahoma (Political Science)

Professional and Society Affiliations

Beta Gamma Sigma
Industrial Relations Research Association, Greater Cincinnati Chapter, Board of Governors, 1967-69; President, 1969-71; Board of Governors, 1970-
National Academy of Arbitrators
Phi Beta Kappa

Fields of Special Interest

Management
Collective Bargaining
Arbitration
Micro-economics

Experience

1981-	Consultant, Research Dynamics Incorporated
1948-	University of Cincinnati
	1955- Professor of Economics
	1955-62 Chairman, Dept. of Economics, College of Business Administration
	1952-55 Associate Professor of Economics
	1948-52 Assistant Professor of Economics
1945-48	University of Wisconsin
	1948 Instructor in Labor History, Labor Problems
	1945-48 Teaching Assistant, Economics, Labor

Publications and Papers

Grievance Arbitration in Public Employment, Public Personnel Association, Chicago, 1970. Included in the 1970 Special Issue of the Public Employee Relations Report, entitled, "Perspective in Public Employee Negotiations," 73-85.

Marketability Study of Project Ohio R-62, with L. Valentine, Ladislas Segoe and Associates, Cincinnati, Ohio (1963).

Transient Housing Study in Support of Project Ohio R-71, with L. Valentine, Ladislas Segoe and Associates, Cincinnati, Ohio (1963).

Grievance Arbitration in Public Employment, Central Regional Conference, Public Personnel Association Workshop, Peoria, Illinois (May 17-19, 1968).

Grievance Procedures in Public Employment, and Impassse Resolution Procedures, Central Region Conference, Public Personnel Association Workshop, Columbus, Ohio (June 6-7, 1968).

Arbitration of Grievances, Public Personnel Association Workshop, Akron, Ohio (May 16-17, 1970).

How to Prepare for Arbitration, and The Arbitrator Makes His Decision, two papers presented at the Conference on Arbitration, International Moulders and Allied Workers Union (August 17-18, 1968). Two similar papers were presented at the Conference for District Representatives, International Molders and Allied Workers Union, Cincinnati, Ohio (December 12 and 14, 1969).

Activities

Wages and Disputes Analyst, War Labor Board, Kansas City, 1944-45

Public Member, Wage Stabilization Board, Cleveland, 1951-52

Member, Mayor's Housing Committee, Cincinnati, 1949-50

Director, British Management Training Program, University of Cincinnati, 1951-52

Public Member and Chairman, Board of Review, 1961-62, and the 1964-65 negotiations between City of Cincinnati and Unions representing city employees

Coordinator, Management Development Program, City of Cincinnati Personnel, College of Business Administration, University of Cincinnati, 1958-59, 1960-61

Private Arbitrator and Mediator in Labor-Management Disputes since 1951. Panel arbitrator in coal mine construction industry

Member, Advisory Committee supervising research project of summer intern for the Model Cities Agency, Cincinnati, summer 1972

Consultant to research group, Department of Management, College of Business Administration, regarding feasibility of team wage incentive for solid waste collection/disposal personnel, 1972-73

Consultant to government agencies and private firms on economic matters, management development, and union-management relations

Chairman, University Faculty Grievance Committee, 1975-77, 1978-80

Member, Promotion, Reappointment and Tenure Committee, Dept. of Economics

Chairman, Ad Hoc Committee to Review Criteria for Promotion, Reappointment and Tenure, Department of Economics

Member, Industrial Relations Committee, Dept. of Economics

Board of Governors, Faculty Club, 1972-78

Participation in various conferences and seminars as expert in Industrial Relations, e.g., American Association of Physical Plant Administration

Chairman, Committee to Inform the Faculty on Collective Bargaining, 1973-74

President, Faculty Club, 1976-77

Chairman, Ad Hoc Committee on the Role of Faculty in Personnel Decisions at University of Cincinnati, 1977-78

Member, Board of Directors, Research Dynamics Incorporated, 1977-

HOWARD H. BOEING

Primary Role in Program: I&C Officer

Mr. Boeing has had over 15 years of experience in the design, construction and operation of laboratory equipment. In addition to working with test equipment of various types, he is intimately familiar with radiation measurements and techniques. Since the founding of RDI in 1977, he has been an active Consultant Research Engineer for the corporation. A summary of his background and experience is given below.

Education

A.S. Electronic Engineering Technology, University of Cincinnati, OCAS
Graduate USAF Weather Observer School - ABR 25231 - 1963

Non-degree courses:

Welding; TIG, Plastic and Stock	OCAS/UC
Phenumatic Instrumentation	OCAS/UC
Practical Electric Wiring	OCAS/UC
Horticulture	UC
Sealess Pump Services School	Crane Corp., Philadelphia, PA

Experience

1977- Consultant Research Engineer, Research Dynamics Incorporated. Participant in various proprietary research and development projects including the development and patenting of a porous lithium oxide production process.

1970- Laboratory Associate Nuclear, University of Cincinnati. Responsibilities: Daily operational supervision of the Nuclear Engineering Laboratories and facilities; design, construction and maintenance of research equipment and instrumentation; provide guidance and instruction to graduate students on their research projects; participate in research and development projects, particularly in the areas of equipment and instrumentation design,

development, construction and operation; supervise, operate and maintain a 2.5 MeV Van de Graaf Accelerator and a 1300 Ci Co^{60} facility.

1966-70 Engineering Assistant, General Electric Company, Nuclear Space Programs Division
Responsibilities: Research and development of radioactive technical ceramic products, particularly in the area of research equipment design constructions and operation.

1962-66 Weather Observer ABR 25251, United States Air Force.
Responsible for the gathering, reporting and dissemination of weather data, including the operation of weather instruments and communication equipment.

1952-62 Grocery Store Helper, Boeing Grocery.
Worked in all phases of a family-owned grocery business.

Patents

Co-inventor of a U.S. patent on a fusion reactor material, No. 4,221,775 (September 9, 1980), "Method of Producing Porous Lithium Oxide."

JANET W. ANNO

Primary Role in Program: Document Controller, Administrative Assistant to Program Manager, and Assistant Purchase Controller

Mrs. Anno has been an officer and secretary of Research Dynamics Incorporated since 1977 when RDI was incorporated and is intimately familiar with the project operations of the organization. A summary of her background and experience is given below.

Education

1958 M.S. The Ohio State University (Education)
1955 B.S. The Ohio State University (Education)

1980 Clermont College
(Engineering Drawing Course)

1977-78 The University of Cincinnati
(9 hours to renew teaching certificate)

Experience

1981- Administrative Assistant, Research Dynamics Incorporated

1977- Corporate Secretary, Research Dynamics Incorporated

1979 (1 Quarter) Supervisor of Student Teachers in Elementary
1977 (1 Quarter) Education for the University of Cincinnati

1964-67 (Part Time) Supervisor of Student Teachers in Elementary Education for The Ohio State University

1963-64 Resource Teacher for the Board of Education of the Columbus Public Schools

1962-63 Supervisor of Student Teachers in Elementary Education for The Ohio State University

1956-60 Teacher of the Third Grade for Clinton Elementary School in Columbus, Ohio