# TENNESSEE VALLEY AUTHORITY
# WATTS BAR NUCLEAR PLANT

## DESIGN AND CONSTRUCTION QUALITY PROGRAM DESCRIPTION AND EVALUATION

Presentation to Nuclear Regulatory Commission
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1. TVA'S Commitment To Quality

TVA's programs for design, construction, and operation of its nuclear facilities are founded on the policy that quality and safety are the overriding requirements needed to fulfill the agency's mission of producing electricity for the Tennessee Valley region as cheaply and efficiently as possible. TVA's Office of Engineering Design and Construction (OEDC) has responsibility for providing assurance that the plant has been designed and constructed to adequate standards of quality so that the health and safety of the public will not be compromised when the plant goes into operation. To fulfill this responsibility, TVA has made and continues to have an unwavering commitment to quality. This commitment to quality is achieved by designing and constructing the plant to the requirements and commitments made in accordance with the license application.

The purpose of this paper is to summarize the basis on which the Office of Engineering Design and Construction management places its confidence that its program will ensure that TVA's nuclear plants are designed and constructed in a way that produces a final product which fully meets the requirements and commitments of the licensing application. Beginning with the agency's policies regarding quality, this document summarizes the TVA organization as a whole and, in particular, the design and construction programs. The process by which design requirements for plant systems, components, and structures are determined, verified, documented, controlled, and transmitted to the construction organization is explained. Then, the construction program which takes these design requirements and fabricates, erects, and works with the operating organization to test prior to licensing the structures, systems, and components described by the requirements is discussed. The additional assurances provided by independent internal and external review programs and organizations apart from the line function are enumerated. Finally, these programs are specifically related to Watts Bar Nuclear Plant. Beginning with the agency's policies below, each of these discussions focuses on TVA's commitment to quality and "why" OEDC management feels confident this commitment is being fulfilled.

1.0 TVA Agency Policies

The Office of Engineering Design and Construction (OEDC) is the principle designer and constructor for TVA nuclear facilities which includes responsibilities for the development of detailed design requirements; procurement; fabrication, construction, and installation of structures, systems, and components; and development and implementation of quality assurance and quality control measures necessary to assure the installation of a safe and reliable facility.

In addition, written requirements commit TVA to use all practical means to protect and enhance the quality of the human and natural environment through compliance with applicable Federal, State and local laws, related regulations, and through the implementation of more rigorous controls or practices where practical and beneficial in the design and construction programs. TVA is also committed to implement safe and environmentally acceptable methods for use, storage, transportation, recycling and disposal of nuclear materials and waste. Procurement policies provide for factors such as relative quality, skill, experience, etc., to override cost considerations in awarding contracts for materials and services.

Four organizations have a major role in providing confidence that the design and construction programs meet TVA's commitments. The first of these is the OEDC Quality Assurance Staff which is established to develop, coordinate and issue requirements for an OEDC quality program for the design, procurement, construction, and installation of nuclear plant projects, and to ensure through audits and followup actions that quality is being achieved. To support and supplement the efforts of this staff, Quality Assurance Branches are established in both the Division of Engineering Design and the Division of Construction to develop and implement programs which assure quality of actions and resulting installation. Finally, the Nuclear Safety Review Staff (NSRS) is established to act independently of TVA organizations concerned with design, construction, operation, support, and quality assurance to advise the General Manager and the Board of Directors on nuclear safety policy; to assist in making decisions affecting the safety of TVA Nuclear Plants; and to provide a broad overview of the adequacy of TVA's nuclear safety programs and line organizations' programs. The OEDC QA Staff, the QA Branches, and the NSRS are described in detail in Section IV.

These agency commitments, policies, and organizational quality and control responsibilities are the basis for the implementing policies of OEDC as the designer and constructor which assure the completion of a safe, reliable, and operable facility.

## 2.0 Office of Engineering Design and Construction Policies

OEDC amplifies the agency policies into actual operating policies for the design and construction organizations through a system of procedurally controlled upper-tier documents.

The OEDC Quality Assurance Program Requirements Manual (PRM) for design, procurement, and construction documents the OEDC policies which are intended to serve as upper-tier requirements for the detailed implementing procedures in the Divisions of Engineering Design and Construction. A summary of the key policy statements follows.

Since the early 1970's, OEDC has kept abreast of the need for new policy statements regarding the quality assurance program. The current PRM policy statement (OEDC-QPM-82-1) states that the objective of the OEDC QA Program is to provide effective controls over activities and records affecting the quality of structures, systems, and components. An audit program is an essential part of this program and must be accepted with a positive attitude. Channels of communication throughout OEDC must be maintained, and each person is expected to perform quality related activities in strict adherence to established procedures. Line management is responsible for quality and must take the initiative to organize and direct effective programs as well as promptly correct ineffective or incorrect procedures.

Policy statement OEDC-QPM-80-1 encourages and protects the views of employees on policy or execution of policy. Employee concerns and differing staff opinions are to be handled without intimidation or reprisal, with special emphasis being placed on employee concerns regarding the design, procurement, construction and operation of nuclear plants. Concerns of OEDC employees related to nuclear safety may be taken directly to the Division QAB Chief, the OEDC QA Manager, the Manager of OEDC, the Nuclear Safety Review Staff, and finally the TVA General Manager (in appeal order). This policy is prominently displayed in all facilities.

OEDC is required by policy statement OEDC-QPM-3-76 to establish and implement training programs which provide quality related developmental or qualification training for personnel engaged in nuclear safety related activities.

Finally, since the Office of Power is the licensing interface between TVA and NRC, OEDC is committed in the PRM to provide a direct channel for the flow of information to the Office of Power for timely transmittal to the NRC and to establish a centralization of such reporting functions within OEDC. This was implemented through policy statement OEDC-QPM-12-77.

In addition to the policies conveyed in the PRM for the design and construction organizations, OEDC has established a controlled procedural manual to specifically address the special considerations necessary to fulfill the requirements of ASME Boiler and Pressure Vessel Code, Section III. The OEDC Quality Assurance Manual for ASME Section III Nuclear Power Plant Components (NCM) requires that the division level quality assurance programs for design, procurement, fabrication and installation are to be complete and meet all regulatory and Code requirements.

The NCM further provides for third party inspection by an Authorized Nuclear Inspector, and establishes the authority of any person having quality assurance/control responsibility to stop further fabrication, installation or use of nonconforming items. Any employee observing a potential nonconforming work condition has the responsibility and authority to identify the condition for proper evaluation which when deemed appropriate results in a stopwork order to cease the subject activity.

Finally, an Interdivisional Quality Assurance Procedures Manual (IPM) has been developed which provides interdivisional controls between the Division of Engineering Design (the designer), the Division of Construction (constructor), and the Division of Nuclear Power (the operator). The requirements reflected in this program provide that (1) an effective line of communication between interfacing divisions will be maintained, (2) management backing for rapid resolution of problem areas will be provided, (3) agreements reached will be reflected in the affected division working procedures, and (4) appropriate training will be provided.

OEDC policies, as documented in these three upper-tier manuals, are integrated into an effective quality assurance and control program through the development and implementation of working level procedures which control the activities and records produced by the design, construction, and operations organizations.

## 3.0 Communication and Implementation of Policy

The final and most directly influential "quality policy" within TVA is the unwritten policy which the managers within the TVA work force are encouraged to communicate and practice daily. This is most accurately reflected in the OEDC Policy Statement on Nuclear Plant Quality and Quality Assurance which is included in the PRM (OEDC-QPM-82-1) and which will be conveyed to the 16,000 OEDC employees in a recent videotape prepared by George Kimmons, Manager of OEDC. This policy statement specifies, in part:

> "We must continually be aware of our commitment to quality at all levels in the organization. It is important that everyone strives to achieve the high quality that is necessary to ensure that our nuclear plants can be operated safely. It is also imperative that everyone recognize and accept the importance of a quality assurance program as the means of providing a systematic and orderly approach to achieve quality of our product.

TVA has a tradition of providing quality workmanship and services. OEDC is known throughout the world for its quality of design and construction. Our mission has been to perform all activities in a manner that will provide assurance that the plants which we design and build are of highest quality at reasonable cost. It is important that we recognize and believe in this tradition and that we preserve and continue this tradition of quality performance, especially as it relates to nuclear plant design and construction.

The line organizations and the persons therein who are responsible for doing the work are also responsible for the quality of their work, and for complying with the requirements of the quality assurance program. The full recognition and acceptance of this responsibility is the foundation of a good quality program. Our quality program will never be what it must be until every employee is committed to quality."

In summary, TVA's policy, whether it be agency, organizational or individual, is of one mind--the quality and safety of our product are the most important commitments we have.

## II. Organization of the Tennessee Valley Authority

The Tennessee Valley Authority is an independent corporate agency of the Federal Government created by an Act of Congress on May 18, 1933. TVA is directed by a three-member, full-time Board, appointed by the President and confirmed by the Senate, to serve for nine-year terms. The President designates the Chairman. The Board is responsible to the President and to the Congress. In addition to the Board, the basic TVA organizational structure consists of a General Manager and his staff, and eight Offices with broad responsibilities for planning and management of TVA programs within their areas of responsibility. The overall relationship among the principal TVA organizational elements is shown in Figure II-1. The responsibilities of the organizational elements which have a significant involvement in TVA's nuclear power program are discussed below.

### 1.0 Board of Directors

The Board of Directors, under the TVA Act, is vested with all the corporate powers of the Tennessee Valley Authority. In general, the Board establishes overall policies and programs; approves projects and specific items which are of major importance; and establishes the basic organization through which programs and policies are executed.

Specifically with respect to TVA's nuclear power program, the Board's responsibilities primarily involve a final approval of staff recommendations for initial project authorizations; major procurement contracts (such as the nuclear steam supply system and turbine-generator); major architect-engineering and personal services contracts for any out-of-house design, construction, or support services; annual budgets for all in-house activities; and the total capital expenditure budgets for each nuclear project. The Board is also involved in the establishment of corporate nuclear policy regarding areas of special concern. Primary responsibility for administering implementation of TVA programs and policies is delegated by the Board to the General Manager and his staff.

Responsibility for planning and managing the design and construction of TVA nuclear facilities is delegated by the Board to the Office of Engineering Design and Construction. Responsibility for planning and managing operation of TVA nuclear facilities is delegated by the Board to the Office of Power.

### 2.0 General Manager

The General Manager is the principal TVA administrative officer and is responsible for coordinating the execution of programs, policies and decisions which the Board of Directors approves or adopts.

He further originates or approves administrative controls to ensure integrated execution of the total TVA program, and reports to the Board on overall efficiency, effectiveness, and economy of TVA operations. The General Manager assigns duties and makes delegations to the TVA offices, divisions, and staffs in their execution of TVA programs and policies. He reviews and approves major TVA management methods, major organization changes within offices and divisions, and major staff appointments, and recommends to the Board basic changes in the TVA organization.

## 2.1 Office of the General Manager

The Office of the General Manager includes Assistant General Managers with specific responsibilities for providing oversight to major program areas, and also staffs which perform specialized duties or aid in expediting, coordinating, and disposing of current business.

## 2.2 Assistant General Manager (Technical)

Within the Office of the General Manager, principal responsibility for corporate administration and oversight of TVA's nuclear power program is assigned to the Assistant General Manager (Technical). This position was established in February 1982 to place a special emphasis at the General Manager's level on matters related to TVA's total nuclear program. The Assistant General Manager (Technical) oversees the activities of the Office of Engineering Design and Construction and the Office of Power. Additionally, he has principal responsibility for providing independent review of all matters relating to nuclear safety and quality assurance in the design, construction, and operation of TVA nuclear facilities. In this regard the Nuclear Safety Review Staff and the corporate quality assurance organization now being formulated report to him.

## 2.3 Nuclear Safety Review Staff

The Nuclear Safety Review Staff acts independently of TVA organizations concerned with the design, construction, operations, and support of nuclear plants and has broad authority to monitor, review, and audit TVA's nuclear activities. Its purpose is to advise the Board on nuclear safety policy, and to advise and assist the General Manager and the Board in making decisions affecting the safety of TVA nuclear plants. It makes recommendations to the line organizations for such changes as it determines are necessary or desirable to enhance the safety of TVA nuclear plants.

The responsibilities of the Nuclear Safety Review Staff do not reduce in any respect the responsibility of other TVA organizations in the ongoing licensing, design, construction, operation, and monitoring of nuclear plants for safe operation. Specific functions of the staff are discussed in Section IV.

## 3.0 Office of Engineering Design and Construction (OEDC)

The Office of Engineering Design and Construction is responsible to the TVA General Manager and Board for the engineering, design, and construction functions for the Tennessee Valley Authority. OEDC is composed of two divisions with the Division of Engineering Design being responsible for the general architectural and engineering functions and the Division of Construction responsible for the construction, erection, and testing of TVA power projects. The Division of Engineering Design and the Division of Construction are headed by managers who have corporate level responsibility for safety, quality, cost and schedule of the design and construction of the TVA nuclear plants. In a decentralized organizational structure such as TVA they act as Architect-Engineer and Constructor.

In September 1981, the responsibility for overseeing the safety, quality, cost, and schedule of the design and construction of Watts Bar Nuclear Plant was centralized in the appointment of an OEDC Watts Bar Project Manager. The OEDC Project Manager enhances coordination of design and construction activities.

The Manager of the Office of Engineering Design and Construction manages the work of the office, which includes the Division of Engineering Design and the Division of Construction. He is assisted by the managers of the divisions, the Watts Bar Project Manager, three assistants to the manager who serve in technical and administrative capacities, a quality assurance manager, and a management services staff.

The OEDC Quality Assurance Staff develops the requirements for an overall Office of Engineering Design and Construction quality assurance program for the design, procurement, construction, and installation of nuclear power plant projects and assures, through audits and followup action, that the quality assurance programs in the Division of Enginering Design and the Division of Construction based on these requirements are being achieved. The organization and function of the OEDC Quality Assurance Program are addressed in Section IV of this report.

3.1 Division of Engineering Design (EN DES)

The Division of Engineering Design is responsible for the engineering, design and procurement of nuclear power plants. EN DES performs such quality related functions as (a) identification of nuclear plant safety related structures, systems, and components; (b) development of design input requirements (design criteria); (c) design and review of all structures, systems, and components not furnished by the NSSS supplier; (d) review of design within the NSSS vendor scope of supply; (e) preparation, review, and approval of various phases of the preoperational test program; (f) preparation of construction drawings and specifications; (g) identification of structures, systems, and components requiring application of quality assurance processes; etc. Further detail on specific EN DES activities is given in Section III.

3.2 Division of Construction (CONST)

The Division of Construction is the corporate-level organization within OEDC responsible for construction, and erection of TVA power projects. Some of the functions which relate directly to quality performed by the Division of Construction include (a) developing and implementing an appropriate construction sequence as detailed by procedures; (b) site work and construction of foundations and structures; (c) receiving, inspecting, and storing all materials and equipment; (d) fabricating and installing assigned parts, components, and appurtenances; and (e) maintaining required inspection and other QA related records. The division is responsible for construction tests and preoperational tests, except that the responsibility for the administration and overall conduct of the entire preoperational test program has been delegated to the Division of Nuclear Power. The Division of Construction is discussed in detail in Section III.

4.0 Office of Power (POWER)

The Office of Power has overall responsibility for the TVA power generation program, which includes power system planning, plant and site selection, plant and system operation, and transmission system design and construction. The general responsibilities of the organizational elements which have a significant involvement in TVA's nuclear power program are discussed below.

4.1 Quality Assurance and Audit Staff (QA&AS)

The Quality Assurance Manager, Quality Assurance and Audit Staff, reports directly to the Deputy Manager, POWER (Energy Supply), and has been delegated the responsibility for defining the requirements and for implementation of an overall Office of Power quality assurance program for the operation and maintenance of TVA's nuclear power plants in accordance with licensing commitments. The Quality Assurance Manager also has the responsibility to audit and evaluate the effectiveness of the operating quality assurance program in implementing the established requirements and to document and report any deficiencies to the Deputy Manager, POWER (Energy Supply), and verify the adequacy of the resultant corrective actions.

4.2 Division of Fuels (FUELS)

The Division of Fuels plans the supply of fuel resources to serve TVA's power demand forecasts. It defines requirements for nuclear fuels and participates with the Division of Purchasing in preparing and negotiating contracts for the procurement and processing of nuclear fuel materials.

4.3 Division of Nuclear Power (NUC PR)

The Division of Nuclear Power is responsible for implementing the POWER quality assurance program and for the safe, efficient, and environmentally sound operation and maintenance of TVA nuclear generating facilities after transfer of the plant systems to POWER by OEDC. The Division is responsible for (a) reactor operation and safety; (b) operator training and qualification; (c) performance of the preoperational test program as delegated by the Division of Construction; (d) performance of the startup test program; (e) routine maintenance activities; (f) field services, including the scheduling, planning, and implementation of outages, major maintenance activities, and onsite emergency preparedness. NUC PR interfaces extensively with the Divisions of Engineering Design and Construction in matters related to the transfer of systems and features to the plant operations staff, preoperational testing, and engineering services related to plant modifications.

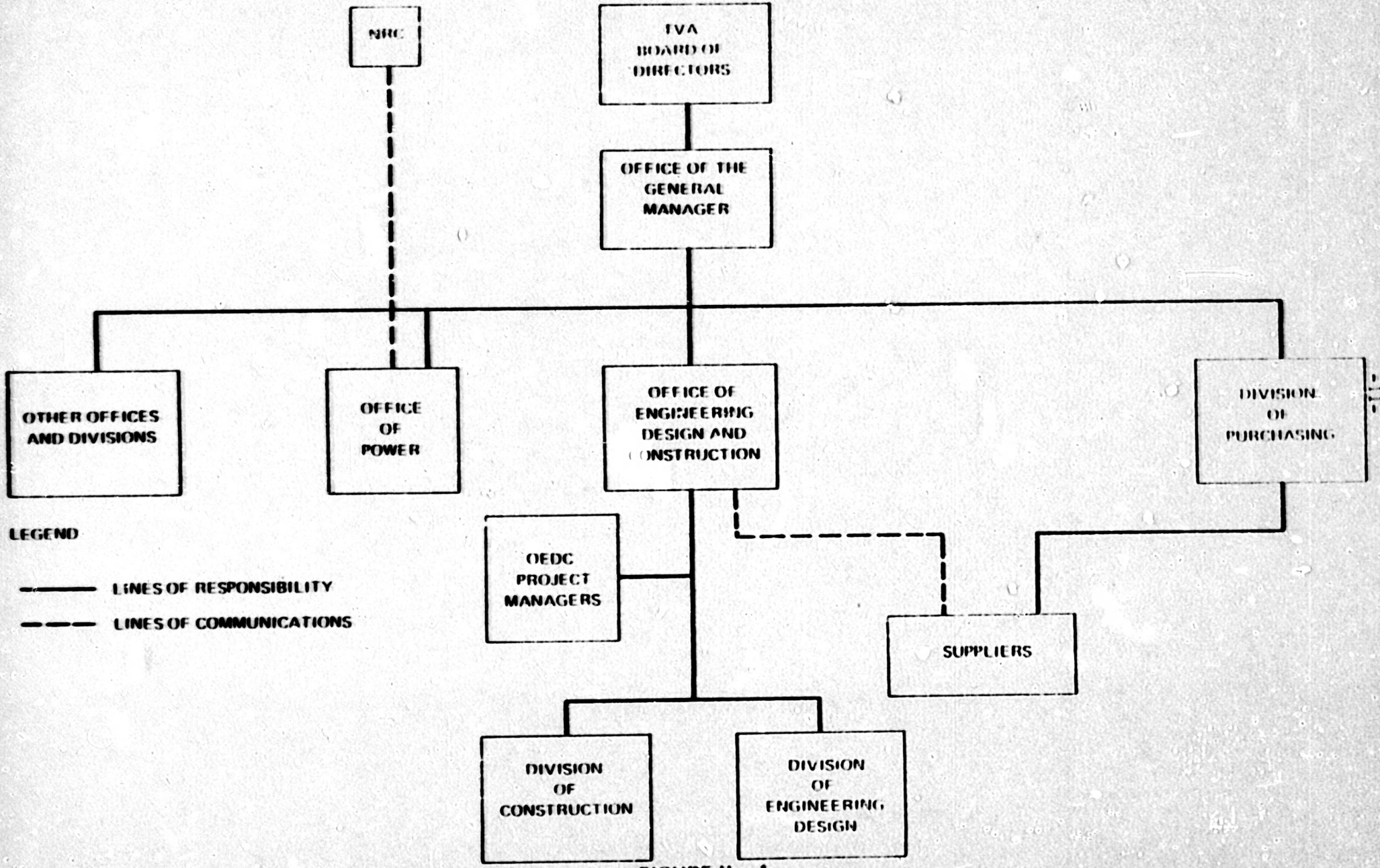


FIGURE II – 1
TVA ORGANIZATION

## III. Office of Engineering Design and Construction Programs

The Office of Engineering Design and Construction (OEDC) serves the dual roles of Architect-Engineer and Constructor for all TVA power production facilities, and has full responsibility for all aspects of the design, procurement, construction, and erection of TVA nuclear facilities. In the past 32 years, OEDC has designed and constructed over 54 individual steam generating units, including the three 1,100 MWe units at Browns Ferry Nuclear Plant and the two 1,170 MWe units at Sequoyah Nuclear Plant. TVA's technical qualifications to design, construct, and operate Watts Bar units 1 and 2 are evidenced by the skills and experience gained over many years in the power business.

The Manager of OEDC is responsible for ensuring that OEDC programs for design and construction of TVA facilities are fully integrated into a comprehensive and thorough management program. An Assistant to the Manager of OEDC is designated to provide special management emphasis and guidance in matters specifically related to the design and construction of TVA nuclear facilities, and assist in integration of the OEDC management programs. Additionally, the OEDC Project Manager for Watts Bar Nuclear Plant provides direct Office level management involvement in matters related to design and construction activities at Watts Bar. With this management structure, the Design and Construction Project Managers for Watts Bar Nuclear Plant functionally report to the OEDC Project Manager, while administratively and procedurally performing their assigned responsibilities within the programs established for their respective Divisions.

The Manager of Engineering Design and the Manager of Construction are each responsible for the development and implementation of coordinated and integrated management programs to ensure that activities which affect safety, quality, cost, and schedule are identified, controlled, and documented to an appropriate level. If there is a conflict involving safety and quality, these requirements always override considerations of cost and schedule. Within this fundamental management approach, special emphasis is placed on those activities which affect the design and construction of nuclear safety-related plant features. This special emphasis ensures that the programs and procedures under which these activities are performed are in compliance with the basic purpose of the quality assurance program. The discussions which follow address the programs in place within OEDC which control and assure the quality of design and construction activities related to nuclear safety-related plant features.

### 1.0 Division of Engineering Design (EN DES)

The Division of Engineering Design (EN DES) is organized in a basic matrix structure which includes the EN DES Manager's Office; a design project for each nuclear plant (except for Watts Bar and Sequoyah, which as sister plants, are in a single design

project); engineering branches with functional responsibilities common to all plants; and administrative support branches which serve both the design projects and the engineering branches. The EN DES organizational structure as it relates to Watts Bar Nuclear Plant is shown in Figure III-1. Activities related to the design of safety-related plant features are generally performed within the Thermal Power Engineering (TPE) branches and the design projects, and are addressed in detail in sections 1.1 and 1.2. The EN DES Engineering Procedures (EP) system is established to provide the necessary level of controls to ensure that these activities are performed, reviewed, and approved within the governing criteria of the QA program. The basic design programs related to definition of design inputs, design review and approval, design change control, procurement control, etc., are implemented by the EN DES Engineering Procedures and are addressed in Section 1.3.

1.1 Responsibilities and Functions of the Thermal Power Engineering (TPE) Branches

The TPE branches are discipline oriented (Mechanical, Nuclear, Electrical, and Civil) and have basic responsibility for the development and verification of basic design input requirements for engineering features of all TVA power plants and for procurement of engineered equipment. For TVA nuclear plants, the TPE branches responsibilities include:

a. Identification of safety-related systems and features, and the development of design criteria, including performance requirements and limitations, service functions such as normal and emergency cooling and electrical power requirements, environmental requirements or constraints, and identifying the applicable Codes, Standards, and Regulatory Requirements.

b. Preparing and assuring the review of information, drawings, and data for Preliminary Safety Analysis Reports and Final Safety Analysis Reports.

c. Preparation of procurement specifications and other procurement activities for materials and equipment, including nuclear steam supply systems.

d. Assuring that all technical requirements of its contracts are met and that vendor-submitted information is sent to the appropriate organizations for design and interface review.

e. Developing the general layout and arrangement of thermal power plant structures and major equipment.

f. Participation in the development, review, and approval of design and construction specifications, standards, and guides which define requirements and necessary controls associated with various design and construction activities.

g. Involvement in development, execution, and review of the preoperational testing and selected startup testing of nuclear power plants.

h. Reviewing proposed modifications to operating nuclear power plants and for assuring that an evaluation is made to determine if an unreviewed safety question is involved.

i. Performance of safety analyses, special analyses, and utilization of special expertise in areas such as fire protection, metallurgy, heat transfer, etc.

The TPE branches thus serve both a lead role in development of plant functional requirements, and a technical support role to the design projects in the development, review, and approval of matters related to detailed design in their areas of expertise. Since the functional responsibilities described above are handled within the TPE engineering branches for all TVA nuclear projects, the design process is strengthened by the free exchange of information and experience between each of the nuclear plant design projects.

Of particular importance in fulfilling OEDC's commitment to safety and quality is the role of the Nuclear Engineering Branch in providing a design review of the nuclear plant features and arrangement and of safety-related systems. This role is more thoroughly discussed in Section 1.4.

## 1.2 Responsibilities and Functions of the Design Projects

The Design Projects are plant oriented organizations with primary responsibility for the development and issuance of detailed design output documents for submittal to the Division of Construction for use in construction and erection activities. Within each design project, the Mechanical, Electrical, and Civil groups are responsible for implementation of the design functions established by the TPE branches. This process involves the development, review, and approval of both conceptual and final detailed designs for plant systems and features. Once the detailed design is sufficiently well developed, the project initiates the procurement cycle by submitting to the appropriate engineering branch a purchase request for required equipment. The design project is also responsible for ensuring that vendor supplied information is incorporated into the detailed design before release to construction.

The design project serves as the primary EN DES interface point with Division of Construction and is responsible for ensuring that sufficient and complete information is provided to the field to support the construction process.

## 1.3 The Design Process

The design of a nuclear power plant is an iterative process which has typically extended over a five to eight year period. During this process, the design of the facility and its constituent structures, systems, and components evolve through several distinct phases from an overall plant conceptual design, to functional configurations of major plant systems and structures, to detailed design output issued for construction use. In reality, there is a significant overlap in these phases for the various systems and structures being designed.

The plant conceptual design phase is generally initiated with the selection of nuclear steam supply system (NSSS) and turbine-generator (T-G) suppliers, and involves those activities associated with development of basic building layout and location of major components. During this time frame, decisions are made relative to general design requirements to be imposed during the design process (such as seismic criteria and spectra, separation criteria for mechanical and electrical, etc.). The plant conceptual design phase is essentially completed by the time the Preliminary Safety Analysis Report (PSAR) is submitted. During this time, some aspects of the plant design (such as structural base plate design) may be finalized and released to the field for construction purposes once a Construction Permit (CP) is obtained.

As more detailed information is developed regarding the major systems and components to be provided under the NSSS and T-G contracts, conceptual designs are developed for those systems, and requirements for supporting systems are identified. This phase typically involves development of systems level functional design requirements (flow, capacity, etc.) and systems configuration (flow) diagrams. A large percentage of this effort is directly related to the development of basic design inputs by the major vendors and the engineering branches, development and issuance of functional design criteria documents for selected primary safety-related plant features, and finalizing system functional configurations. As this effort progresses, the Final Safety Analysis Report (FSAR) is developed and submitted to the NRC.

As the basic design is completed, it is reviewed by experienced engineers for compliance with the intent of the safety analyses and for compliance with licensing commitments. These engineers

have usually been involved in the initial phases of the licensing process. In general, however, commitments and inputs are widely communicated so that any engineer involved in the review process can better prform his function.

As various structures and systems progress through the design process, detailed design output documents are completed and issued to the field for use in fabrication and construction. The development of these design output documents requires that all design verification necessary to support the design be complete. Great care is taken to produce design documents of high quality and considerable detail. As design progresses on other related systems, and as design evolves (as a result of new or revised design standards and/or regulatory requirements), the majority of these issued documents are revised.

Because of the iterative nature of the design process, the long time frame over which design activities are performed, and inevitability of design changes, the design process must be structured in a manner to assure that these activities are performed in an approved and controlled manner. The discussions which follow provide a functional description of the programs in place within EN DES to control the design process. These programs are incorporated into the EN DES Engineering Procedures (EP's) as an integral part of the design control process, and are applied to design activities on safety-related plant features. The EP's are functionally oriented procedures which define control and approval requirements, and are generally applied to all design activities, including those associated with nonsafety-related plant features. The programs addressed below provide the basis for TVA's assurance that plant structures, systems, and components are designed appropriately for their intended function and application.

1.3.1 Design Inputs

As stated above, the TPE Engineering Branches are responsible for development of the basic design inputs upon which detailed design output is based. For systems designed by TVA, these design inputs are typically specified in Design Criteria documents which define the functional performance requirements (flow, temperature limits, etc.), governing codes and standards, regulatory requirements (as interpreted from 10CFR50, Regulatory Guides, etc.), environmental qualfication requirements, design bases, etc.

Additionally, design inputs (both performance requirements and equipment data) are received from vendors through the procurement cycle. Such inputs include system functional design requirements developed by the NSSS vendor for

systems under the NSSS scope of supply which must be incorporated into the design of systems developed by TVA. A simple example involves specification of cooling water requirements for pumps supplied under the NSSS contract. Design inputs of this type are handled under the EN DES procedures for contract administration, and are reviewed and approved before incorporation into the design process.

Procedures for development of Design Criteria documents govern the content and format of the documents, as well as the preparation and approval process. The draft document is reviewed internally by the responsible organization prior to submittal to an independent reviewer within the branch. The independent reviewer performs a complete verification of the document for technical adequacy and accuracy. Once the draft criteria has been approved by the independent reviewer, it is submitted to all other affected EN DES organizations for review for completeness, clarity, and interface with associated systems and features. After satisfactory resolution of comments, the document is signed off by the preparer, coordinated with all reviewing organizations, and approved by the responsible manager. Issued design criteria are then distributed as controlled documents to all affected design organizations and are used to develop detailed design output. Changes to Design Criteria are also reviewed and approved by affected design organizations in a manner similar to that for approval of the original issue.

1.3.2 Design Review

Each Engineering Procedure which governs the various aspects of the design process requires that design work receive an appropriate level of review prior to approval and issuance. As specified in section 1.3.1, design criteria documents are verified by an independent reviewer and by affected EN DES organizations before approval. Similar review requirements are imposed on all design output documents (including drawings, calculations, and procurement documents) before approval. The conscientious review and approval of each step of the design process provides assurance that the final design is based on valid design criteria which have been accurately developed.

1.3.3 Interface Review

Interface review is necessary to ensure that the design of plant systems and features has adequately addressed the interface and interaction between plant systems and

between the disciplines within a system. These interface reviews are normally performed as an integral part of the design and design review process. The development of system design criteria and system level configuration drawings (such as flow and logic diagrams) require review by affected organizations to ensure that these interface reviews are performed. Specifications for equipment also receive this review.

Additionally, the EN DES procurement process (section 1.3.4) ensures that vendor supplied inputs (both performance requirements and equipment data) are reviewed by the contracting branch for compliance with contract specifications and for consistency with TVA design criteria.

For vendor supplied inputs such as those provided under the NSSS contract, this constitutes a major interface review. Vendor supplied equipment data is also reviewed by the design project for detailed interface requirements and for incorporation into design output documents. This review includes verification that actual equipment data is consistent with that used in final design calculations and analyses.

1.3.4 Procurement and Contract Engineering

Procurement and contract engineering responsibilities for various types of equipment is assigned to the TPE or Special Projects Engineering and Design (SPED) engineering branches in EN DES. Contract engineering responsibilities include preparation of specifications and other procurement documents (such as explanatory drawings), evaluation of bids, recommendation of award, technical administration of contract, engineering review of vendor documents, and monitoring of contract performance. Technical administration of contracts is done by trained personnel at the engineer or engineering aide level. These personnel and their managers have experience in procurement and engineering of equipment within their area of responsibility. Standard specifications are used to provide continuity and to make maximum use of previous performance experience. Engineers who certify ASME design specifications are registered professional engineers, qualified in their specific field.

The design project is responsible for producing detailed design information which may be used in the preparation of procurement documents, reviewing vendor documents for

interface control, and coordinating the flow of information between the Divisions of Engineering Design and Construction.

The EN DES Quality Assurance Branch (QAB) is responsible for the EN DES QA program and performs independent reviews of procurement activities to assure conformance with the QA program. As required by the contract technical specification, the Quality Engineering Branch (QEB) provides surveillance of procured equipment at the manufacturer's site for compliance with contract requirements, witnesses performance tests, and releases equipment for shipment. The Division of Construction performs a receipt inspection of material and equipment onsite and storage equipment and TVA's Division of Purchasing has responsibility for administrative and commercial contractual matters.

Procurement Process

For equipment other than certain major engineered equipment, a purchase request (PR) is typically prepared by the design project and submitted to the appropriate TPE or SPED contract engineering branch. The PR provides design data, QA classification, safety classification, seismic category designation, technical interfaces, environmental conditions, and codes and standards requirements. For major engineered equipment, the basic equipment requirements are compiled from applicable system design documents. Design calculations are used where necessary to define engineering data for use in specifications.

A contract technical specification is developed to define the detailed requirements for the procured equipment, including safety classification, performance requirements, interface conditions, environmental conditions, QA classification, applicable codes and standards, and necessary supplier inspection and testing. When interfaces or specialized requirements (such as seismic analysis) are included in the technical specification, the contract engineer coordinates those requirements with organizations having expertise in that area. For equipment procured in accordance with ASME Section III, a qualified professional engineer performs this review and certifies the design specification. Changes to the technical specification require a revision which is handled in the same manner as the original technical specification.

Using the guidelines provided by the EN DES engineering procedures, the contract engineer prepares a requisition package which contains the technical requirements, schedule of prices, quantities involved, delivery and shipping information, and documents quality requirements, and legal and commercial aspects of the contract.

The purchasing organization uses the requisition and standardized commerical conditions to prepare the Invitation to Bid. Before the bids are sent to EN DES, a purchasing agent evaluates bids for commercial responsiveness.

The contract engineer evaluates the bids for technical responsiveness primarily ensuring the bid satisfies technical requirements. The QA program for the low evaluated bidder is submitted to QAB for evaluation of the submitted QA program. If needed, a survey of the contractor's QA, engineering, fabrication, and financial qualifications is conducted.

The recommendation is reviewed and approved by management and QAB and then sent back to the purchasing agent. Purchasing prepares the contract documents, obtains necessary management approvals, and notifies the contractor of award.

Contract Administration Process

The contract engineer reviews drawings, procedures, instruction books, and other documents for contract compliance including contract scope, conformance of the equipment to the technical specifications, and adequacy of the equipment design. As needed, groups within the engineering branches and the design project perform technical and interface reviews of vendor documents at the request of the contract engineer. Comments and corrections are returned to the vendor for resolution and document revision in accordance with applicable engineering procedures. Approved vendor documents are distributed in a controlled manner to all affected organizations and to OEDC's central records management file.

Nonconformance reports (NCR's), as described in Section III.4.0, at the vendor's facilities are controlled and dispositioned in accordance with the contractor's QA program. The QEB representatives monitor these NCR's as part of their documentation review.

If required by the technical specification, the Quality Engineering Branch performs a final inspection of the equipment and documentation package and issues a release for shipment.

EN DES QAB periodically audits OEDC organizations who are responsible for procurement activities and contractors to assure that QA procedures are being followed and that QA records are being properly generated and stored. This QAB function is discussed in Section IV.

QA records for procured equipment are handled in accordance with requirements of the technical specification, the contractor's approved QA program, and TVA's QA program. The documentation package for the equipment is sent to the construction site for storage.

Prior to contract closure, the contract engineer reviews the contract and confirms to the purchasing agent that all technical and documentation requirements have been completed. Following the completion of all commerical aspects, including the delivery of and payment for the equipment, the purchasing agent notifies the contractor and the contract is officially closed.

1.3.5 Change Control

The EN DES design process ensures that control of design changes is performed in a manner consistent with the original design review and approval. The basic mechanism for control of design changes is the Engineering Change Notice (ECN), which is initiated and controlled by the design project. The ECN process requires that the scope of the change be defined, affected drawings identified, and the change be reviewed and approved prior to initiating the formal change. The degree of review and approval by the engineering branches is based on the scope of the change as determined by the design project. For minor changes, provisions are established for the design project to approve changes without review of the TPE branches. Once the ECN is approved, control of the design change is performed in accordance with the established design process. As specific drawings are revised, they receive a review consistent with the significance of the change and previous review requirements. The combined EN DES and CONST ECN processes require that all ECN's be tracked until all aspects of the change have been field implemented. This tracking requirement is a part of the OEDC configuration control program.

The design change control process also includes procedures for processing of Field Change Requests (FCR's) initiated by the Division of Construction. The FCR process is typically utilized to provide timely resolution of minor construction problems related to interferences, tolerance adjustments, etc. The scope of changes which can be processed via the FCR process is strictly limited to ensure that changes are properly controlled. The FCR process involves the responsible construction engineering unit initiating the FCR and contacting the responsible design engineer in the EN DES design project. The design engineer has the authority to verbally approve or disapprove the change request. The design engineer also has the authority to request more information, such as marked up drawings, sketches, etc., if he feels this is required to reach a proper decision. If approved, the construction engineer proceeds to implement the change and submits the FCR package, including agreed to sketches or drawings, to the EN DES design project for incorporation into a future drawing revision.

In addition to the ECN and FCR processes, TVA utilitizes a Design Change Request (DCR) process whereby plant operational personnel from the Division of Nuclear Power (NUC PR) can request changes to the issued design. Typically, plant operations personnel are not actively involved during the development of detailed design and only become involved during the operator training cycle and during preoperational testing. This process provides a mechanism for plant staff and operations personnel to initiate changes which they feel would improve plant operability. Once a DCR is approved, an ECN is initiated to control and implement the change.

Finally, procedures and controls are established which govern the review and approval of design changes initiated by TVA suppliers and vendors. These controls are addressed in Section 1.3.4 as an integral part of the EN DES procurement process.

## 1.4 Additional Design Assurance Programs

In addition to the basic design control programs addressed in Section 1.3, EN DES is actively involved in a number of programs which provide additional assurance that the design of safety-related plant features is complete and adequate; that design errors are identified and corrected; and that the final plant configuration at the time of licensing is certified to be adequate for safe plant operation.

The Nuclear Engineering Branch (NEB) is responsible for the technical administration and control of the NSSS contract and for coordinating EN DES activities and interfaces relative to the NSSS design. The NSSS contract Scope of Supply provides a clear definition of the NSSS vendors' scope of responsibility for providing design input information to TVA for review and approval. This design input information consists of: (1) preliminary design input in the form of pertinent design criteria, engineering data, and parameters for preparation of detailed design; (2) detailed design information in the form of drawings for construction or fabrication and complete information for specifications and procurement; (3) specific information on purchased equipment including purchase specifications and equipment drawings; and (4) selected drawings for review and approval for conformance to specifications and adaptability to other equipment or systems. As indicated in the NSSS scope of supply, TVA has the right to review for pertinent comments or information and the right of review with the option of acceptance or rejection of the information.

As addressed in Section 1.3, the EN DES design control process requires the review of vendor documents to assure proper coordination of interfaces with TVA portions of the plant design, compliance with contract requirements, and detailed technical review of selected documents and design features. Because systems provided under the NSSS contract have such a significant impact on plant safety and operation, EN DES has been especially thorough in our review of the NSSS design. The engineering branches (TPE) review of NSSS design submittals has included detailed reviews of the system design criteria and accident analyses, system configuration and logic drawings, and equipment specifications. In several instances, TPE's indepth review of the NSSS design has resulted in improvements to the vendor's basic design, and has enhanced plant safety.

In addition to this NSSS review, a primary mission of the Nuclear Engineering Branch is to provide a design review of nuclear plant features and arrangements and of safety-related systems to assure maximum overall plant safety and compliance with applicable regulatory requirements.

These responsibilities are accomplished through selective reviews of safety-related systems and features and include activities such as:

a. Developing basic plant design concepts and reviewing overall nuclear plant design and arrangement to help assure overall plant safety.

b. Developing general criteria, design input, and safety-related design bases for nuclear plants, including interpretations of NRC requirements as they apply to specific plants.

c. Reviewing selected design criteria developed by others in EN DES.

d. Reviewing safety-related systems developed by TVA to assure they comply with criteria and basic design parameters.

e. Reviewing design documents furnished by the NSSS vendor and other contractors to assure that they comply with applicable NRC regulatory requirements.

f. Providing interpretations and consultation to the nuclear plant design engineers of various discipline on design bases and safety requirements.

g. Interpreting NRC requirements related to overall plant safety and participating in discussions with the NRC relative to such interpretations.

h. Maintaining specialized knowledge and expertise in nuclear plant safety requirements including general design criteria, regulatory requirements, accident analysis, integrated safety system performance, overall plant performance, and preoperational testing.

The Nuclear Engineering Branch is also responsible for coordinating for EN DES the development and execution of the preoperational test program. These responsibilities include identification of required tests, development of test scoping documents for each test, review and approval of test instructions, participation as required in onsite test execution, and review and approval of test results. The EN DES test representatives responsible for establishment of system test requirements and for review and approval of test results are selected from the TPE branches or the design project based on their knowledge of system design and functional requirements. Typically, these test representatives are those individuals responsible for the system design criteria or for development of

detailed system design. Involvement of knowledgeable individuals who are actively involved in the system design effort helps ensure that the preoperational tests verify the system functional requirements. Additionally, these individuals are involved in development of any design changes necessary to correct any deficiencies identified during testing. The preoperational test program is addressed in more detail in Section 3.0.

## 1.5 Division of Engineering Design Certification of Approval to Load Fuel

An important aspect of the design process is to assure that the as-designed plant configuration is identical to the as-constructed plant configuration, with any deviations being documented and approved by EN DES. Established processes to assure design review of the as-constructed plant configuration prior to fuel loading have been implemented by approved procedures. The following section outlines these established processes.

### 1.5.1 Coordination Team

Coordination team members from Engineering Design (EN DES), Construction (CONST), and Nuclear Power (NUC PR) have been assigned and are functioning for Watts Bar. The primary responsibilities of this team include: (a) reviewing all incomplete work activities as identified by the outstanding work items list (OWIL) and identifying, coordinating, and expediting the completion of items required for fuel loading (the coordination team also coordinates the rescheduling of work activities if an impact on fuel loading or other immediate need is identified) and (b) maintaining a comprehensive status of these items and meeting on a regular basis to expeditiously handle the items.

### 1.5.2 Outstanding Work Items List (OWIL)

The OWIL is a list of the incomplete construction work identified at the time of system transfer. The list also serves as the document required to identify any licensing exceptions and continues as the system required to identify outstanding modifications. The list includes items such as: ECNs, unresolved preoperational test exceptions, and incomplete original construction.

Before unit licensing, EN DES will make an evaluation of the OWIL to determine whether or not the incomplete work could affect the safe startup of the unit. Documentation of this review will be accomplished by written Unimplemented Design Item Evaluations.

1.5.3 Unimplemented Design Item Evaluations (UDIE)

Procedures state the EN DES responsibilities, criteria, and methods of evaluating and reporting of any original design and/or approved design changes that are unimplemented at the time of fuel loading. Each OWIL item will be reviewed to determine if it is required for fuel loading relative to:

a. Nuclear Safety

b. Licensing

c. Operation

If the review indicates that the item is required prior to fuel loading for any of the three criteria listed above, coordination with CONST and NUC PR will be initiated to ensure implementation of the item prior to fuel loading.

1.5.4 As-Constructed Drawing

Procedures define the interfaces and responsibilities of EN DES, CONST, and NUC PR as they relate to the control of drawings from the time of first transfer (from CONST to NUC PR) of systems until licensing of the last unit. Procedures apply to the control of drawings to support the identification of the as-constructed status of systems and covers the development of control processes such as (1) the certification of as-constructed drawings, (2) the operation of the Drawing Control Center (DCC), (3) the implementing of the drawing information system (DIS), and (4) the approval of plant configuration for fuel loading.

A simplified outline of the approval of plant configuration for fuel loading is as follows:

a. CONST requests and receives from EN DES reproducibles.

b. CONST marks reproducibles showing the system's construction configuration and distributes copies of the marked drawings.

c. EN DES receives the drawings from CONST for review and either returns to CONST for further work those construction drawings unacceptable for fuel loading, or processes for distribution those drawings acceptable for fuel loading.

d. NUC PR receives from CONST and assumes control of as-constructed drawings and revises drawings as required following implementation of subsequent modifications to maintain the drawings in a current as-constructed configuration.

1.5.5 Drawing Information System (DIS)

The drawing information system is a computer data base of information pertaining to the status of TVA drawings, TVA contracted design drawings, and manufacturer's drawings.

The DIS has sort capability on an ECN basis, as-designed basis, and as-constructed basis. This provides the capability to obtain a list of the latest revision as-constructed drawings for any system on a given date (for example, fuel loading date).

The DIS construction status is maintained for all drawings required to perform work or verify equipment configuration after tentative transfer.

1.5.6 10CFR50.55(d) Requirements

10CFR50.55(d) requires the applicant to supply any necessary information to update the original license application (FSAR) prior to OL issuance. In addition, the applicant is required to identify significant outstanding items that may be required to support plant operation and assess the impact of these items at the time of unit licensing.

Existing engineering procedures establish the process used in updating of the FSAR as required by 10CFR50.55(d). As for the identification of outstanding items to NRC, the Nuclear Licensing Section (NLS) of the Nuclear Engineering Branch coordinates the compilation of a list covering unresolved technical issues and significant incomplete field work that may not be closed before fuel loading and includes the necessary justification for the incomplete status of these items. This list is coordinated with POWER prior to submittal to NRC.

1.5.7 Tracking and Closure of Deficiencies

Within OEDC, the NLS is responsible for evaluating for reportability all significant nonconformances (NCR's) and audit deficiencies identified prior to receipt of an operating license and assuring that all commitments made to NRC as part of the resolution of these conditions are

met. Logs of all significant conditions identified to NLS are kept informally within the section. These logs are published monthly by NLS and distributed formally to the affected organizations.

1.5.8 Preoperational Testing Program

The preoperational test program includes provisions for specifying the milestone by which each test must be performed. The status of the preop test program is reviewed to assure that tests required prior to fuel load have been performed, test results reviewed and approved, and test deficiencies controlled. This program also includes controls to assure that system modifications after completion of the preop test are evaluated to determine the necessary extent of postmodification testing.

A preoperational test deficiency is a condition identified during testing in which any equipment being tested either: (1) fails to operate, (2) operates in a suspected adverse manner, or (3) operates outside the limits of documented acceptance criteria. EN DES reponsibilities during the preoperational testing phase includes an evaluation of each deficiency to determine the actions necessary to resolve the deficiency. Part of the evaluation is the determination of the milestone by which unacceptable deficiencies must be resolved. All deficiencies are tracked to ensure resolution prior to the designated milestone. Further detail concerning the preoperational test program is provided in Section III.3.0.

A preoperational test restraint is a condition found prior to testing which (1) requires completion, procurement, installation, or analysis of equipment and (2) could inhibit or delay testing.

By the very nature of restraints, resolution is accomplished prior to performing the associated preoperational test. Resolution tracking is accomplished in EN DES, CONST, and NUC PR to ensure completion compatible with the preoperational test schedule.

1.5.9 Unreviewed Safety Question Determination (USQD) - 10CFR50.59

Existing procedures describe the method by which EN DES handles proposed changes, tests, and experiments for nuclear plants after receipt of an operating license in regard to determining if an unreviewed safety question

exists. The procedure also includes how EN DES handles items determined to be an unreviewed safety question (i.e., obtain NRC approval). Procedures also apply to EN DES performing unreviewed safety question determination for design work completed prior to licensing but which will not be physically implemented in the plant until after licensing.

Specifically for the latter situation, unreviewed safety question determinations are accomplished prior to physical implementation of the proposed modifications which have previously been identified to be completed following fuel load (and approved to be postponed). This will assure implementation of modifications commensurate with the NUC PR modification schedule.

1.6 Summary

The results of these evaluations provide the basis for EN DES certification that the as-constructed plant configuration at fuel loading acceptable from a nuclear safety, licensing, and operation perspective.

2.0 Division of Construction

OEDC customarily builds its own facilities and performs engineering activities with its own employees. This is done to ensure high standards of implementation, efficiency and economy, and to facilitate coordination of related activities. OEDC's use of the force account method of construction provides several benefits for TVA over the AE-constructor method. The most significant benefit is the close association between OEDC (design and construction) and POWER (operations). With this arrangement, the architect-engineer, the constructor and the owner are all parts of the same "company." The same "company" will also retain responsibility for the plant after operation. Alterations required due to changes in technology or interpretation of requirements can be implemented effectively without the contract changes that would be required with the AE-constructor method.

The Division of Construction (CONST) is the organization within TVA responsible for the construction of the TVA nuclear facilities. CONST is part of the dual project management program used by TVA to manage both the design and construction of these facilities under a single office (OEDC).

The following sections discuss the organization and operation of CONST and define the programs implemented by CONST which provide the assurance of a quality installation which will meet all design requirements and commitments.

## 2.1 Organization of Construction

The Manager of CONST is responsible to the Manager of OEDC for the technical and administrative planning and direction of all activities required to construct assigned projects. The manager is responsible for quality assurance in construction and makes certain that the construction organization is adequate to accomplish its quality assurance responsibilities. He assigns responsibilities for quality assurance as appropriate within the division.

### 2.1.1 Office of the Manager

In addition to two principle construction assistants and three administrative assistants, the Manager's office, located in Knoxville, contains four support staffs to assist in the areas of project control, scheduling, payroll, accounting, management systems, and welding support. The Knoxville office also includes the Construction Services Branch (CSB). CSB provides mobile construction support by performing miscellaneous facility modification work throughout TVA as assigned. An organizational summary for the Division of Construction is provided in Figure II.2.0.

The Division of Construction Quality Assurance Branch (QAB) is also a part of the Manager's Office. CONST QAB is responsible for establishing and auditing the implementation of the quality assurance program for the division. CONST QAB is discussed in detail in Section IV.

### 2.1.2 Construction Project Organization

The heart of the construction organization lies in the site construction operations. Each nuclear project is constructed by a site project organization managed by a Project Manager who reports administratively to the Assistant Manager of Construction in Knoxville and the OEDC Project Manager. The Project Manager is responsible for constructing the plant in accordance with design and quality requirements. He is also responsible for assuring the adequacy of his organization to accomplish its quality responsibilities and for ensuring that the importance of quality assurance requirements are understood by the craftsmen and their supervisor as well as by the onsite engineering organization. He periodically reviews the status and adequacy of the construction program and keeps the Manager of Construction informed of all major matters including those relating to quality. The Project Manager is assisted by the Construction Engineer, the Construction Superintendent, and the Project Management Services Supervisor. The Watts Bar site organization is shown in Figure III-3.

The Construction Engineer is responsible for site engineering including interfacing with the design organization and is delegated the responsibility for quality control. The Construction Superintendent is responsible for physical construction of the plant in accordance with requirements established by engineering. The Project Management Services Supervisor provides management systems, project controls, warehousing, cost accounting, and training in some areas for the project. The Construction Engineer and Construction Superintendent's organizations are discussed in more detail below.

The Construction Engineer is responsible for interpreting, clarifying, and providing implementing procedures for all design requirements received in the form of drawings, specifications, purchasing documents, and other upper tier requirements. These procedures are designed to control engineering, construction, inspection, testing, and documentation activities for items under the QA program and are in the form of Quality Control Instructions (QCI's) for activities affecting quality other than quality control inspections; Quality Control Procedures (QCP's) which describe quality control inspection requirements, inspection criteria, and recordkeeping requirements; and Quality Control Test Procedures (QCT's) which contain the requirements for construction testing. Administrative activities are covered in Field Instruction Procedures (FI's). The Construction Engineer's organization performs all quality control inspections and documentation. Other responsibilities assigned to the construction engineer include interfacing with the design organization and providing engineering services as required by the construction organization.

The Construction Engineer is assigned primary responsibility for quality assurance by the Project Manager. He assures that quality assurance requirements are met for all site construction activities. He directs the activities of construction engineers in their respective areas of responsibility and assures that they receive necessary control documents and information from other TVA organizations, manufacturers, fabricators, site erectors and contractors, and from the NSSS vendor. He is also responsible for the training of QC inspectors and the orientation and instruction of site personnel connected with activities affecting QA. He coordinates and resolves major quality problems which have not been resolved through normal channels or refers such matters to the attention of the Project Manager for resolution. He is also the site QA representative and in this capacity he acts as coordinator for the construction project between the site and the CONST QAB Chief.

The Construction Engineer is assisted in carrying out his responsibilities by Assistant Construction Engineers serving as project engineering, quality control, and quality management supervisors. The duties of the Quality Management Supervisor are explained in Section 2.3. Assistant Construction Engineers have duties similar to the Construction Engineer and assume the responsibilities of the Construction Engineer during his absence.

The Watts Bar construction engineering organization contains professional engineers in the various disciplines and additional employees who are basically career employees who have experience from a number of previous TVA projects. Other employees in the organization include clerical, support, and contract employees. The engineering organization is divided into engineering units based on engineering disciplines such as mechanical, electrical, welding, etc.

Engineering personnel provide technical direction and assistance in the scheduling of construction activities. QC personnel verify that activities have been correctly performed and are independent of the group directly responsible for performing the activity. All personnel are qualified, as appropriate, according to the ASME Code and other requirements. Engineers are given orientation programs as to the requirements and procedures of QA and QC where appropriate and QC personnel are certified and given special training by qualified personnel in their particular field.

The Construction Superintendent is responsible for maintaining trades and labor forces and constructing the plant in accordance with requirements established by the Construction Engineer. Most of the managers in the Construction Superintendent's organization are career employees who have worked for TVA on other projects. This experience in the TVA organization is one of the primary benefits of the force account method of construction used by OEDC. There are approximately 62 managers and 2,508 trades and labor employees in the Construction Superintendent's organization.

## 2.2 Construction's Operations

Each of the operations described in the following functional areas forms a part of TVA's construction program. Many of these operating concepts are evolving and changing as tighter controls become necessary. The items discussed in this section apply specifically to Watts Bar Nuclear Plant, but the concepts and especially the lessons learned are being applied at the other active TVA nuclear construction sites.