CRBRP RELIABILITY ASSURANCE ACTIVITIES

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RELIABILITY ASSURANCE

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I. Introduction

This document describes the activities that contribute to assurance that CRBRP will be designed, constructed and operated so that public health and safety will be reliably protected. The CRBR Project is conducting numerous activities, using both conventional "design" and other innovative methods to achieve this reliability. This document describes those activities that enhance and assure the reliability of CRBRP.

A. Reliability Assurance Activity Objective

The objective of the reliability assurance activities is to provide additional assurance that the inherent reliability in the CRBRP design concept is achieved and that the likelihood of exceeding the offsite radiological dose guidelines of 10CFR 100 is acceptably low. The overall aiming point of these activities is to assure that the risk to the public from CRBRP is comparable to that from a current LWR.

B. Methods of Achievement

The methods of achieving reliability for CRBRP are varied. All reflect the underlying proposition that reliability must be designed into the plant as an integral part of the design process. Analytical methods include Safety Analyses, Probabilistic Risk Assessment, Key System Reviews, and Systems Interaction Analysis. In addition to these analytical methods, other project activities are important to assuring reliable operation of the plant. These include methods of Design Control, Equipment Testing, Equipment Qualification, Failure Evaluation, and a comprehensive Quality Assurance Program.

The initial CRBRP reliability assurance activity is through application of established and demonstrated nuclear power deterministic criteria. Other reliability assurance activities in CRBRP contribute to achieving the inherent reliability in the design by conducting both qualitative and quantitiative assessments.

The "Safety Analysis" program was performed to provide a measure of the consequences of postulated accidents and to obtain the process parameters which form the design basis of the plant.

The "Safety-Related Reliability" program is focused on reactor shutdown and removal of decay heat. Program activities include qualitative reliability analyses at the component and system levels, and quantitative analyses at the shutdown and heat removal functional levels.

Failure mode and effects analyses and common cause failure analyses are performed on selected safety systems through a combined effort by design engineering and reliability engineering. This qualitative analysis emphasis is on first-of-a-kind components that are unique to CRBRP technology. Disposition of identified concerns or uncertainties require agreement by the design and reliability organizations. Required actions are tracked to resolution in a project control system.

Logic models are constructed to quantitatively predict the failure probability of the reactor shutdown and shutdown heat removal functions. Information obtained using the models is considered in development and refinement of the plant design.

The qualitative FMEAs & CCFAs from this activity which primarily address first-of-a-kind equipment are used as a data input to the Probalistic Risk Assessment and the Systems Interaction Analysis programs.

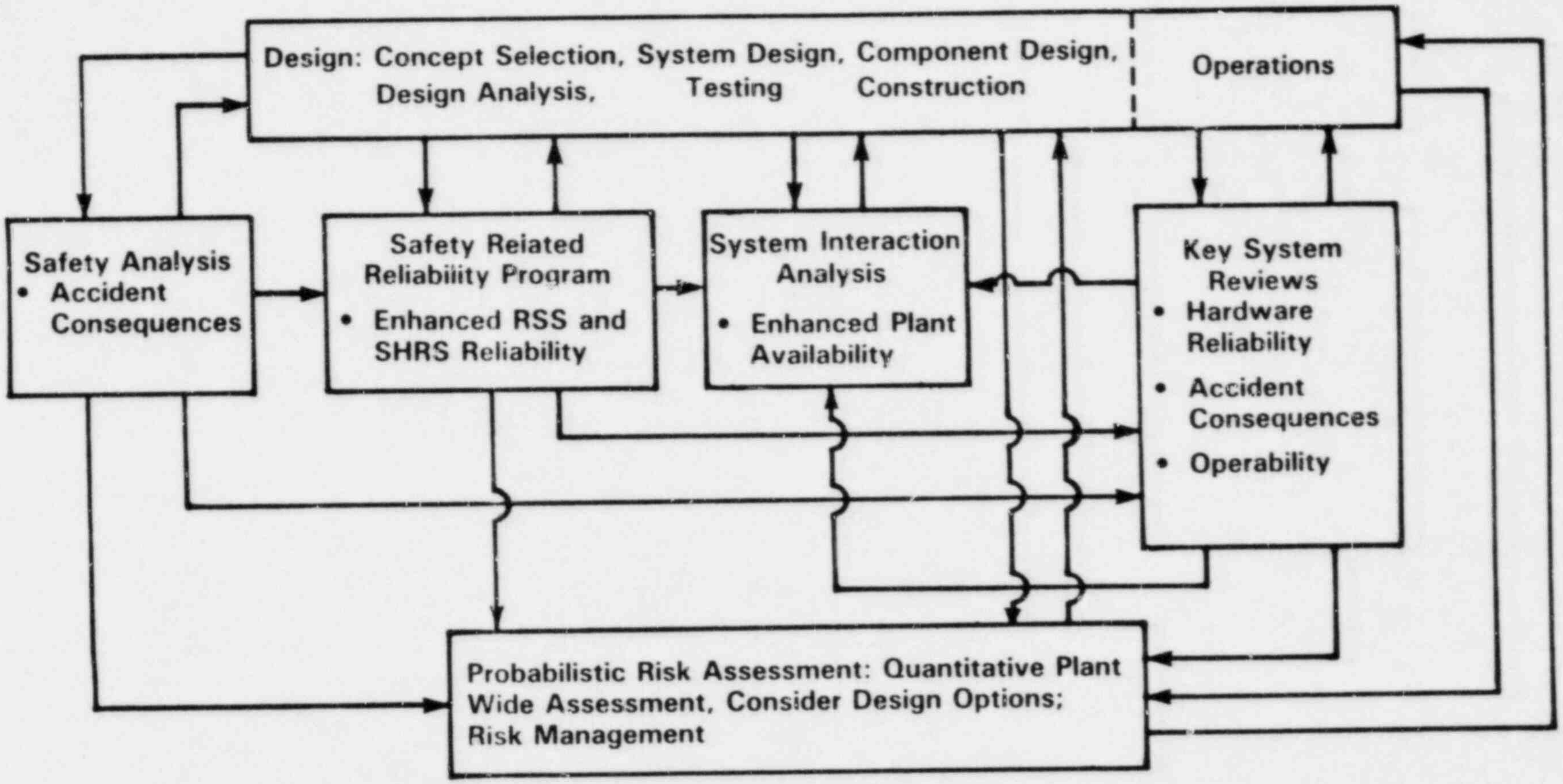
An overall plant "Probabilistic Risk Assessment" (PRA) model is being developed to quantitatively assess the public health and safety consequences of CRBRP operation. The risk model uses event tree fault tree methods to develop the accident sequence logic from accident initiating events to categories of radiological release from containment. Health consequences are then computed by atmospheric dispersion and demographic modeling methods. The PRA addresses all safety and supporting plant systems and their potential for interaction and misoperation. It includes the systems designed to mitigate accidents (e.g., containment cleanup and isolation) and addresses ex-core radiological sources (e.g., spent fuel storage, cover gas, etc.). This model will have applications for continuing risk management throughout the life of the plant. A prime objective during construction of the plant risk assessment is to address subjects not previously addressed by other activities in the analytical depth necessary to support quantification (i.e., supporting system interactions, common cause events, and operator error potential).

The PRA is a comprehensive overall assessment of CRBRP risk. However, no one methodology can address all objectives of a thorough reliability assurance program. Other CRBRP activities are in place that supplement the PRA and Safety Related Reliability Program. These include: the "Key System Reviews" whose primary objective is to assure operator controllability of the plant under accident conditions; the "Systems Interaction Analysis" program whose primary objective is plant availability for power production, but which secondarily contributes to plant reliability by reduction of shutdown transient challenges to the plant safety systems; the "Equipment Testing" programs that demonstrate performance, operational, and to a considerable degree the qualitative reliability characteristics of components and plant systems; the "Equipment Qualification" program that assures environmentally sensitive equipment can perform their functions under anticipated service conditions; and the "Failure Evaluation" program that assures corrective action for the cause and mode of equipment failures experienced during the plant equipment development programs. The interactive flow of information between the reliability assurance activities is illustrated in Figure I-1.

The foundation of a successful reliability assurance program is in assurance that the design that is defined and analyzed is the design that is built. The "Quality Assurance Program" for CRBRP provides this reliability assurance function.

In summary, the objective of integrating reliability into the design for CRBRP is achieved by several means.

1. Application of proven principles and design concepts.
2. Application of the NRC deterministic criteria in the conceptual and detailed design phases of the program.



Quality Assurance: Minimizes design error; Minimizes fabrication and construction errors; Assures valid safety, reliability, operability, availability, etc. analyses.

Figure I-1 CRBRP Assurance That Doses in Excess of 10 CFR 100 Guidelines Will Be Reliably Avoided

3. Application of several reliability and other methods to evaluate and enhance the design.

4. Application of design process controls that treat reliability concerns with the same degree of importance as other engineering disciplines (e.g., structural thermal, hydraulics, etc.).

5. Systematic design development through progressively detailed baselines.

6. Application of a comprehensive quality assurance program to assure the design, evaluation and construction are properly implemented.

II. Program Activities

A. Design for Reliability

Initial efforts are directed towards overall plant criteria, the definition of system requirements, and the development of system concepts which meet the basic objectives for the Project. System and equipment designs proceed through progressive stages of increasing detail until the design is completely defined. During the progressive stages of the design process, formal design reviews for each major system and/or piece of equipment are scheduled and held by the responsible design contractors.

A design review is conducted on all systems and selected components at discrete points in the design phase, specifically at completion of the concept design (approximately 30 percent design completion), at completion of the preliminary design (approximately 60 percent design completion), and at the 90 percent design completion stage a final design review is held. Satisfactory completion of this review is the basis for the final design baseline.

The design requirements developed during the design process are defined in an hierarchy of documentation, as defined below:

1. **Overall Plant Design Description** - The top-level configuration document and controlling specification.
2. **System Design Descriptions** - The principal means to establish, describe and control the individual system designs from conception throughout the lifetime of the system.
3. **Equipment Specifications** - The principle means to establish, describe and control the individual equipment designs from conception throughout the lifetime of the equipment.

4. **Specifications, Drawings and Instructions** - To support the equipment specifications, additional documentation is prepared in the form of specifications covering such items as materials, processes and testing, engineering drawings, assembly drawings, detail drawings, flow diagrams, process and instrumentation diagrams, electrical schematics, wiring diagrams, interface control drawings, installation drawings, and instructions in the form of procedures and manuals covering processes, testing, operation and maintenance.

5. **Engineering Calculations and Studies** - Each design contractor conducts and documents engineering studies and/or calculations to support the selection and basis of the system design parameters, principal features and characteristics including analysis of "trade-offs," where appropriate.

6. **Parts, Materials and Processes** - Proven parts, materials and processes are used wherever possible. To ensure that all CRBRP design work is based upon one common set of materials data as well as on consistent extrapolations and interpretations of these data, a Nuclear Systems Materials Handbook has been established.

7. **Interface Control** - System and equipment functional parametric, and physical interfaces are controlled for all portions of CRBRP by Interface Control Documents that require approval by the interfacing design organizations.

8. **Design Control** - Each design contractor implements configuration management procedures as a means of controlling design activities and products produced by them.

9. **Design Verification** - Design verification is the process of reviewing, confirming or substantiating the design by one or more methods to assure that the design meets the specified design requirements. Design verification is performed by competent individuals or groups other than those who performed the original design.

10. **Design Reviews** - The "design review" team is interdisciplinary and represents several specified areas of expertise. The defined task is to review the design presented by the design team and to assess the degree to which it meets the specified design requirements. The design team and its upper management are responsible for actions on the findings in a way that fulfills the requirements.

11. **Alternate Calculations** - Verification of some types of calculations or analysis is achieved by comparison with

alternate methods of calculation or analyses that also address the appropriateness of assumptions, input data, and the code or other calculation method used.

12. **Development and Environmental Qualification Testing** - Design verification of some designs or specific design features is achieved by test of a prototype or initial production unit. Testing demonstrates adequacy of performance under the most adverse design conditions.

13. **Parallel Studies** - Parallel studies are conducted to establish the necessity, feasibility, or desirability of alternate concepts which depart from the base concept.

14. **Manufacturing** - The design contractor responsible for the performance in service of their engineered products imposes instructions and requirements on the manufacturer via a comprehensive engineering specification to assure that the product performance is not compromised during manufacture, packing, shipping, storage, and installation.

15. **Quality Assurance Program** - The ultimate quality of the plant will be the result of two basic functional, processes, one which may be characterized as an "achieving" process and the other as an "assuring" process. The "achieving" functions are those work activities associated with planning, designing, manufacturing, constructing, and operating. The "assuring" functions are those work activities associated with planning, controlling, inspecting, testing, surveillance, auditing and recording.

B. Evaluation and Enhancement of Designed Reliability

The inherent reliability of CRBRP, as designed in, and controlled by the processes previously described are evaluated for reliability that has been achieved and for the potential of further enhancement by conduct of both analyses and testing activities.

Most analytical and testing activities on CRBRP systems and equipment contribute to the the reliability assurance function, however, those activities that are most directly applicable to the reliability assurance disciplines and methods will be described.

1. Safety Analysis

a. **Objective** - The objective of safety analysis conducted for CRBRP is to evaluate the consequences of various failures and combinations of failures of plant equipment. The results of the analysis provides a measure of the consequences of the postulated accidents. In addition, the analysis results indicates the importance of various failure modes with respect to public health and safety. Further the analysis is undertaken to obtain the process parameters (pressure, temperature, etc.) which form the design basis of the plant.

b. **Description** - The safety analysis performed by the Project ranges from qualitative evaluations, to simplified quantitative analyses (hand calculations), to complex detailed quantitative assessments involving one or more computer codes. The accident scenarios are chosen and the analysis assumptions are selected using engineering judgment and deterministic safety and design criteria. These assumptions reflect qualitative assessments of the reliability of plant equipment to operate and thus mitigate accidents under a range of loadings. Analyses have been performed for minor events, design basis accidents, and events beyond the design basis such as HCDAs.

c. **Products** - Much of the CRBRP safety analysis is documented in PSAR Chapter 15 and in CRBRP-3, "Hypothetical Core Disruptive Accident Considerations in CRBRP." In addition to these analyses of design basis and beyond the design basis events, analyses have been performed for variations of these events. Many of these parametric and sensitivity analyses are documented in response to the NRC questions, in letters to the NRC or other Project documents. Some specific examples of such documents are:

- WARD-D-0185, "CRBRP Integrity of Primary and Intermediate Heat Transport System Piping in Containment"
- WARD-D-308, "Summary Report on the Current Assessment of the Natural Circulation Capability with the Heterogeneous Core"
- PSAR Appendix B, "General Plant Transient Data."

d. **Feedback to the Design** - The results of the safety analysis for plant design basis events are used to establish the compliance of the plant design with regulatory guidelines. If the specified regulatory guidelines are not met, the design is changed. In addition the results of safety analysis are used in the following ways in the design evolution process:

- The analysis results are used to establish process performance and structural capability requirements for plant equipment. For example the analysis of the plant duty cycle events establishes the pressures and temperatures to which heat transport system equipment is designed.

- The predicted environments in the plant resulting from various accidents are used as input in the equipment qualification program discussed in Section II.7 of this document.

- The safety analysis results provide insight into the importance of various areas of the design. This insight is valuable in determining the allocation of Project resources to the various areas of design both for the design function itself as well as for other reliability assurance activities.

e. **Responsibility and Authority** - The safety analysis for CRBRP are conducted by a combined effort of the CRBRP safety organizations and design engineering organizations. Applicant (CRBRP Project Office) has full responsibility and authority for safety analysis. The Project Office Assistant Director for Public Safety has ultimate responsiblity for the PSAR in which the safety analysis are documented and the Project Office Assistant Director for Engineering is responsible for the engineering analysis of the ability to accommodate design bases events. Westinghouse and its subcontractors and Burns and Roe are contractually responsible for performing the analysis. The analytical inputs to the PSAR are prepared by the contractors engineering, and safety analysis organizations as requested by the CRBRP Project Office.

f. **Schedule** - The preliminary safety analysis was conducted and documented in the PSAR. Updating of the PSAR will continue until a licensing basis acceptable to the NRC Staff has been established. The final safety analysis will be provided in the FSAR.

2. Safety Related Reliability

a. **Objective** - Probabilistic and deterministic reliability methods are being applied to the design process for CRBRP. The purpose of the safety related reliability program is evaluation and enhancement of the plant design concept. The resources allocated to the program are concentrated primarily on first-of-a-kind equipment unique to CRBRP technology. The basic objective of the program is to provide additional assurance (beyond the normal design process) that the equipment and systems required to perform safety functions will meet their performance requirements and the predicted probability of exceeding the radiological release guidelines defined in 10CFR 100 is acceptably low.

b. **Description** - All significant quantities of radiological species in CRBRP were evaluated and as a result of the evaluation, it was determined that the focus of the program activities should be on prevention of loss of coolable geometry in the reactor core. An imbalance between heat generation and heat removal in the core must occur before there is a potential for release of radioactivity from the core. Two plant systems are provided to assure that such an imbalance does not occur. One is the reactor shutdown system (RSS) which includes the plant protection system's ability to detect and process critical plant parameter anomalies into shutdown commands and the primary and secondary control rod systems ability to respond to those commands by insertion of sufficient negative reactivity to successfully shut the reactor down. The other is the shutdown heat removal system (SHRS) which includes four paths (three main heat transport loops and the direct heat removal service) each with capability to remove the total decay and sensible heat load following shutdown initiation at full power. The reliability program focus is on systematic failure analysis of the components, subsystems, and systems whose failure to function could degrade these two missions.

In order to formalize the program's focus and scope, a reliability-related critical item list was issued to the program participants, in the form of an Interface Control Document, that itemizes the systems and subelements that require analysis. This document defines the baseline analytical requirements for conduct by design engineering, with the assistance of reliability engineering, within the lines of responsibility for the design of each system. The analyses are conducted as a part of the design process and are scheduled (along with other engineering analysis) to support the design review milestones.

This deterministic reliability program consists of failure mode and effects analysis, common cause failure analysis, and summarization of the assessment and its findings at selected levels up to the system level. These summary assessments are presented as an integral part of the design at final working system design reviews conducted by the Project Office.

The quantitative reliability program is conducted at the RSS and SHRS mission levels. Logic models are constructed and quantified for each of these missions to allow calculation of mission failure probability. The dominant contributors to mission failure probability are identified. Studies are conducted to evaluate the sensitivity of predictions to failure data uncertainties and modeling assumptions. Proposed modifications to the design or operational procedures are evaluated for improvement potential.

Testing programs supportive of the safety-related reliability program are discussed in Section II.6 of this document.

A more extensive discussion of the reliability program including analysis and supporting test programs is provided in Appendix C of the PSAR.

c. **Products** - The deterministic reliability evaluations based on FMEA and CCFA analyses are being documented at the system level. A reliability design support document is produced for each RSS and SHRS system in the program.

The systems for which RDSD's will be produced are:

Reactor System
Reactor Enclosure System
Plant Protection System
Plant Control System
Reactor and Vessel Instrumentation System
Flux Monitoring System
Primary Heat Transport System
Intermediate Heat Transport System
Steam Generator System
Steam Generator Auxiliary Heat Removal System
Reactor Heat Transport Instrumentation and Control System
Auxiliary Liquid Metal System
Inert Gas Receiving and Processing System

The quantitative reliability assessments for the RSS and the SHRS, including the failure rate bases, are documented as:

Reliability Assessment of CRBRP Reactor Shutdown System
Reliability Assessment of the CRBRP Shutdown Heat Removal System

d. **Feedback to the Design** - The prime objective of making the design organization an active partner with reliability engineering in the conduct of reliability analyses (FMEA and CCFA) and the assessments as an integral part of the design process is to effect early feedback into the design. When possible, depending on the design stage, some reliability concerns or uncertainties identified by the analyses can be resolved immediately by the designer. In these cases the analysis is modified to reflect the resolution prior to its publication. In cases where final resolution is not possible prior to publication, the concern or uncertainty is dispositioned in the assessment as an open issue and entered into the Project's Centralized Action Commitment Control System for tracking to a final resolution.

   Design feedback from the numerical modeling and quantitative assessments is through identification of the dominant contributors to the probability of failure prediction. Proposed modifications to the design or operational procedures are evaluated for improvement potential. Those that indicate significant improvement potential are then subjects of additional engineering analyses to evaluate their practicality. When the change is practical and the reliability improvement significant, the change is submitted through the normal project engineering change proposal process.

e. **Responsiblity and Authority** - Because the safety-related reliability program is an integral part of the design process, the resource allocation to the program is through the Engineering Division of the Project Office. The Assistant Project Director for Engineering has ultimate responsibility and authority. However, the Project Office Public Safety Division is actively involved in the policy decisions and technical format of the program.

The Westinghouse (Oak Ridge) Licensing Manager has responsibility for technical management of the program. Westinghouse provides technical direction and guidance to the reactor manufacturers in the performance of the qualitative reliability program tasks for systems under their design cognizance.

Similar direction and guidance as well as integration activities are performed by Westinghouse for the quantitative reliability program tasks.

f. **Schedule** - The deterministic reliability analyses (FMEA, CCFA and their summary assessments in RDSDs) are working documents scheduled to be available to support FSWDRs. Since the FSWDRs are scheduled at approximately 90 percent of design completion for each system these documents often require additional effort to close out all open reliability issues prior to final publication. Some instances where major test programs are involved, the final publication date may be delayed beyond the FSWDR for several months.

A "Reliability Assessment of CRBRP Reactor Shutdown System" (WARD-D-0118) has been published. An update of the "Reliability Assessment of CRBRP Shutdown Heat Removal System" (NEDM 14082) that reflects the current design will be published in early 1983.

3. Probabilistic Risk Assessment

a. **Objective** - The CRBRP Probabilistic Risk Assessment (PRA) was initiated principally related to the desire of the Project to perform an integrated safety assessment as one more ingredient in the decision process leading to safe design and operation. The PRA will also satisfy the requirements of NUREG-0718, Section 11.B.8 and it is consistent with the current direction of the NRC in development of safety goals and PRA applications. The Project envisions extensive application of the probabilistic methods to better understand the plant capabilities during the final design process, the licensing process, and the transition into the demonstration and operational phases of the program. the PRA will provide the analytical methodology to extend Project understanding into areas not previously analyzed in depth by other reliability assurance activities.

b. **Description** - The PRA consists of the following major elements:

- Accident Initiator Development: The approach to logic model construction emphasizes the investigative nature of the task and results in an iterative process for accident initiating event identification. A preliminary list of initiating events is developed by extracting information from a variety of sources. These sources include:

  - compilations of generic experience
  - previous PRAs
  - CRBRP Project documentation
  - breeder reactor experience

  The resultant list of initiating events allows the event tree and fault tree analyses to commence, but is not considered a final list. It is important that information gained during the event tree/fault tree development task be continuously fed back into the task of identifying a comprehensive list that umbrellas all important events.

- System Functional Event Tree Development: Before event tree construction begins, the individual initiating events are grouped into categories based on their impact on the plant and the resulting response of plant safety systems. The approach used to construct the event tree logic for each initiating event category is as follows:

  - determine the functional requirements which must be met in response to the initiating event

  - define the plant systems available to perform each of the necessary functions

  - order the required systems by sequence of plant response to the initiating event

  - develop the event tree accident sequence logic from initiating event to all possible plant states.

- System Functional Fault Tree Development: Fault trees will be drawn for most event tree headings and initiating events where appropriate. Decisions to develop individual fault trees are based on the recognition that the purpose of a fault tree is to:

- quantify the probability of an event for which no statistically acceptable data exists by logically breaking down the event into its constituent parts for which acceptable data do exist, and/or

- identify potential dependencies between multiple system

Fault tree analysis will be performed using procedures and symbols in NRC's Fault Tree Handbook (NUREG-0492).

Fault trees are developed at the following functional levels:

- shutdown heat removal top logic
- primary and intermediate heat transport
- steam generation and heat sinks
- main feedwater and condensate
- turbine bypass valves and condenser
- steam generator auxiliary heat removal
- auxiliary feedwater
- direct heat removal service
- normal and emergency chilled water
- plant service water
- Class 1E electrical
- containment cleanup
- annulus filtration
- annulus air cooling
- compressed gas
- containment isolation

Each fault tree will include appropriate support systems such as electric power, instrumentation and control, instrument air, and service water.

A fault tree data base will be produced which will allow quantification of all fault trees.

- Analyses of Plant Response: Plant system responses to postulated accident sequences will be analyzed during the PRA modeling activity to ensure that the plant response logic is realistic and all dominant risk contributors have been identified. Engineering analyses will be performed when appropriate to assure that system success criteria is realistically based on the physical capabilities of the plant. The success criterion (prevention of core damage) will be formulated and the analysis supporting the rationale for the criterion will be provided.

- Accident Sequence Quantification: Using the initiating events, event trees, fault trees, and associated data bases, the accident sequences will be quantified. This activity will include:

  - A description of the linking process to ensure dependencies between initiators and fault trees, and between different fault trees are identified and incorporated into sequence quantification.

  - A listing of the dominant accident sequences and a description of each.

  - A systematic justification for omitting any sequence from the dominant list.

  COMCAN III (COMmon Cause ANalysis) developed by Idaho National Engineering Laboratory will be used in the generation of cut-sets for accident sequence quantification.

- Uncertainty Analysis: Early in the PRA best estimate quantification and sensitivity studies will be utilized to provide information on the relative importance of equipment and human failures. Detailed uncertainty analysis will be delayed until later in the PRA program since their function is to establish uncertainty bounds in the overall results of the PRA study.

- Common Cause Failure Analyses: Common cause failure analyses will entail

  - explicit event tree, fault tree modeling of dependencies

  - qualitative CCFA of failure causes that may fall below the practical level of resolution in event trees and fault trees (i.e., manufacturing, installation, or maintenance errors

  - detailed CCFA will address internal plant environmental causes that could affect redundant components in different locations

  - special CCFA investigations will address fires, seismic events and other significant external events (e.g., tornados, floods, aircraft impacts, etc.)

- Core and Containment Accident Modeling: Plant logic modeling and quantification will result in a set of dominant accident sequences each of which is expected to produce damage to the core. Many accident sequences do not lead to core damage. The plant state for each accident sequence leading to core damage will be described.

- Phenomenological Event Trees: Phenomenological event trees will be prepared for core behavior resulting from accident sequences that lead to core damage and for containment behavior for accident sequences that progress to breach of the primary reactor boundary. The combined core damage and containment event trees will start with a definition of the plant state and terminate with a description of either a stable coolable state for the core debris or the time and size of the containment failure. The radioactive source term above the operating floor at the time of a stable end point or containment failure will be defined. The major physical processes occuring within the primary system and containment which precede, cause, and follow, hydrodynamic core disassembly and/or loss of core coolability will be described. Consideration of the thermal margins in CRBRP to mitigate consequences of core damage and structural margins to mitigate energetic effects will be included. Both the core damage and containment event trees will be quantified. The bases for selecting probabilities for each response node will be documented.

- Source Term Evaluation: An analysis will be performed to define the environmental source term for each of the unique paths through the containment phenomenological event trees for which significant releases of radionuclides are expected. The potential for release and related health effects from ex-core sources of radionuclides including radioactive cover gas, ex-vessel spent fuel storage and other auxiliary systems will be evaluated using fault tree analysis techniques and appropriate source terms.

- Health Consequence Analysis: The ex-plant consequence analysis will characterize the distribution of public health consequences of hypothetical radionuclide releases to the environment. The characterization of health effects will be accomplished using the CRAC-II computer code together with the meteorological and demographic data for the CRBRP site.

- Risk Assessment: Based on the health consequences, release categories, and sequence probabilities derived in the above tasks an overall assessment of the risk from operating CRBRP will be provided. An assessment of the major contributors to risk including design and operational aspects and sensitivity to key assumptions will be kept current with knowledge of the plant and the PRA model.

- PRA Applications Tasks: A number of PRA applications will be implemented. These applications rely on two characteristics of the PRA:

  - The PRA is a complete description of the accident sequences which have the potential to cause damage to the core.

  - The PRA model incorporates sufficient information to allow a realistic ranking of the importance of equipment failures, systems interactions, and human errors to the frequency of core damage and public health risk.

- Operator Action Event Trees: Operator action event trees will be developed as a method to investigate the plant operations staff's role in important accident sequences. The analyses will address three fundamental questions:

  - What actions should the operator take in response to specific accident conditions?

  - What information is required by the operator to take this action?

  - What instrumentation is necessary and sufficient to provide this information?

  By developing logic models and supporting information that address these questions systematically, a detailed description of the operators role in managing an accident sequence can be developed. The adequacy of the information available to the operator for understanding and management of plant conditions will be assessed.

- Plant Design Changes: When considered necessary the PRA model can be utilized to assess the potential benefits or lack thereof associated with postulated changes in the plant design. These changes may be oriented toward reducing the frequency of events which produce core damage or mitigating the consequences of these events. The cost effectiveness of alternative postulated changes can be assessed.

- Improve Understanding of the Plant: Additional PRA application will be undertaken to factor insights gained from the PRA into the design and operation of the plant. These applications will:

  - Supplement the existing programs designed to address operator aids.

  - Assist the development and validation of emergency procedure guidelines.

  - Support development and utilization of the plant simulator for operator training.

  - Assess the sensitivity of CRBRP risk to uncertainties in the reliability of equipment required to peform its function in an accident environment.

  - Evaluate the risk contribution and sensitivities to testing intervals of equipment and to allowable on-line maintenance intervals.

- Implementation of a Continuing Risk Management Program: The PRA will have application as a tool to evaluate operational experience and to address licensing issues during operation of the plant. The CRMP will be designed to transfer the PRA technology to the TVA plant staff for application throughout the life of the plant.

- Site Emergency Procedures: The PRA will support development of the site emergency procedures. By using the PRA estimates for timing of accidents together with the effect of meteorology and demography, various strategies can be evaluated to minimize population exposure.

A more complete description of the PRA program is provided in Appendix J of the PSAR.

c. **products**

- Initiating event top logic and initiator completeness analysis
- Probabilistically quantified accident sequences and their basis
  a. fault trees
  b. system functional event trees
  c. core damage phenomenological event trees and quantification
  d. containment phenomenological event trees and quantification
  e. detailed common cause failure analysis (systems interaction evaluation)
  f. external event evaluation (seismic, etc.)
- Uncertainty analysis
- Radionuclide release analysis
- Health consequence analysis
- Analysis of ex-core sources of radionuclides
- Definition of program to support continuing operational applications
- Operator action event trees and applications to operations support and training programs
- Definition of an on-going risk management program
- Evaluation of potential risk reduction associated with suggested design changes
- Evaluation of risk contribution and sensitivities to equipment testing intervals (tech. spec. impact)
- Detailed documentation of study and final report

d. **Feedback to the Design** - Design and procedural feedback from the PRA will be through the Project's formal engineering change control process. The results of the PRA will be evaluated and sensitivity studies of the major risk contributors will be conducted to identify if and where significant and cost effective risk reductions are appropriate and practical. If important changes are identified, they will be presented to project management as an engineering change proposal.

e. **Responsibility and Authority** - The Assistant Director for Public Safety has responsibility and authority for conduct of the PRA. The Public Safety Division staff is providing technical management for the program which is being performed by a group of contractors independent of the project's design contractors. The project contractors responsible for the CRBRP design are participating in the PRA product review process to assure accurate representation of the plant systems and their capabilities.

f. **Schedule**

Description	Due Date
Provide final written accident sequence definition review	3/31/83
Provide final written radionuclide release analysis	12/31/83
Provide final written uncertainty analysis	10/31/84
Provide final written detailed common cause failure analysis	10/31/84
Provide final written accident delineation report	10/31/84
provide final written health consequence analysis	10/31/84
Provide written risk management program report	12/31/84
Provide written operator action event trees report	12/31/84
Provide written input to operational procedures and testing intervals	12/31/84
Provide written input to site emergency plan	12/31/84

Provide final written report 12/31/84

4. Key System Reviews

It was realized that as a result of TMI-2, a number of formal changes and procedures would occur in the licensing process. It was also felt that the CRBRP design should not wait for these formal changes to occur without a thorough review. As a consequence, the Project management decided to select some subjects for review to assess the need, if any, for changes to any design features, guidelines, or assumptions used for CRBRP. There was no intention to use these reviews to replace the normal Final Design Review process. The Project management team selected the reviews to be conducted, established the objectives, identified the team chairmen and composition by discipline, and established a senior management Project Steering Group that provided periodic interactive guidance to the review teams.

The systems selected are required to function during normal and off-normal events without creating an undue risk to the health and safety of the public or the plant operating staff. Twelve of these reviews have been completed and one is currently ongoing. These reviews primarily focused on the safety aspects of the plant design. However, where appropriate, the plant design was reviewed considering the qualitative economic aspects associated with mitigating the consequences of and recovery from off-normal events.

A summary report on the conduct of the Key Systems Reviews has been submitted to NRC via reference (1).

Reference (1) Letter HQ:S:82:005 John R. Longenecker to Paul S. Check, "Summary Report on the Conduct of the CRBRP Key System Reviews", Docket No. 50-537, dated February 19, 1982.

a. **Objectives** - The overall objectives of the review team efforts were generic in nature and are summarized by the following:

   1. Evaluate the operation of all interfacing systems that are required to support the overall functional service, (e.g., reactor decay heat removal). The interaction of safety and non-safety-related systems, if any, was considered.

   2. Evaluate the operations, maintenance and tests aspects of the systems.

   3. Evaluate the system and or component failures with respect to both safety and protection of plant investment considering the following:

      - initiating failures
      - multiple failures
      - automatic or operator action to detect and recover from postulated failures
      - man-machine interfaces
      - identify potential paths for radioactivity release

   4. Make recommendations to enhance the design and document the review team effort.

b. **Description** - As a result of the maturity of the CRBRP systems design and the evolving TMI-2 lessons learned, the senior engineering management of the CRBRP Project Office, Westinghouse Lead Reactor Manufacturer and Burns and Roe made the decision to perform a comprehensive review of key functional areas of the plant considering: 1) operations important to the protection of the health and safety of the public and operating staff, 2) protection of the plant investment, and 3) lessons learned from TMI-2. As a result, the following functional categories were reviewed:

   1. Decay heat removal from fuel located within the reactor vessel.

   2. Decay heat removal from spent fuel located within the plant areas external to the reactor vessel.

3. Potential release of radioactivity, whether it be liquid, gaseous or solid, to the plant environment or plant environs.

4. The initiating and functioning of the containment isolation system and the plant areas defined as the confinement system to mitigate the consequences of a radiation release.

5. The potential for radioactive and non-radioactive liquid metal (sodium or NaK) release into the Reactor Containment and Reactor Service Building cells.

6. The potential for liquid metal/water reactions during operation and maintenance conditions.

7. Hypothetical events beyond the design base.

8. Man-machine interfaces specifically related to the main control room.

9. The potential for radioactive and non-radioactive liquid metal (sodium and NaK) release into the Reactor Service Building cells.

10. Normal and off-normal environmental control of the plant in the air and inert gas filled cells.

11. Plant response during and after seismic events.

12. Electrical power distribution interrelationship as it supports the automatic and operator action required to control the plant during normal and off-normal power conditions.

13. Plant response due to normal and off-normal events in the Primary and Intermediate Heat Transport System cover gas systems.

All reviews have been completed except that associated with item (12) above which is in progress.

With the selection of the review topics and team composition the review process was initiated. Figure II-4-1 is a Flow Chart depicting the generic process used in the review.

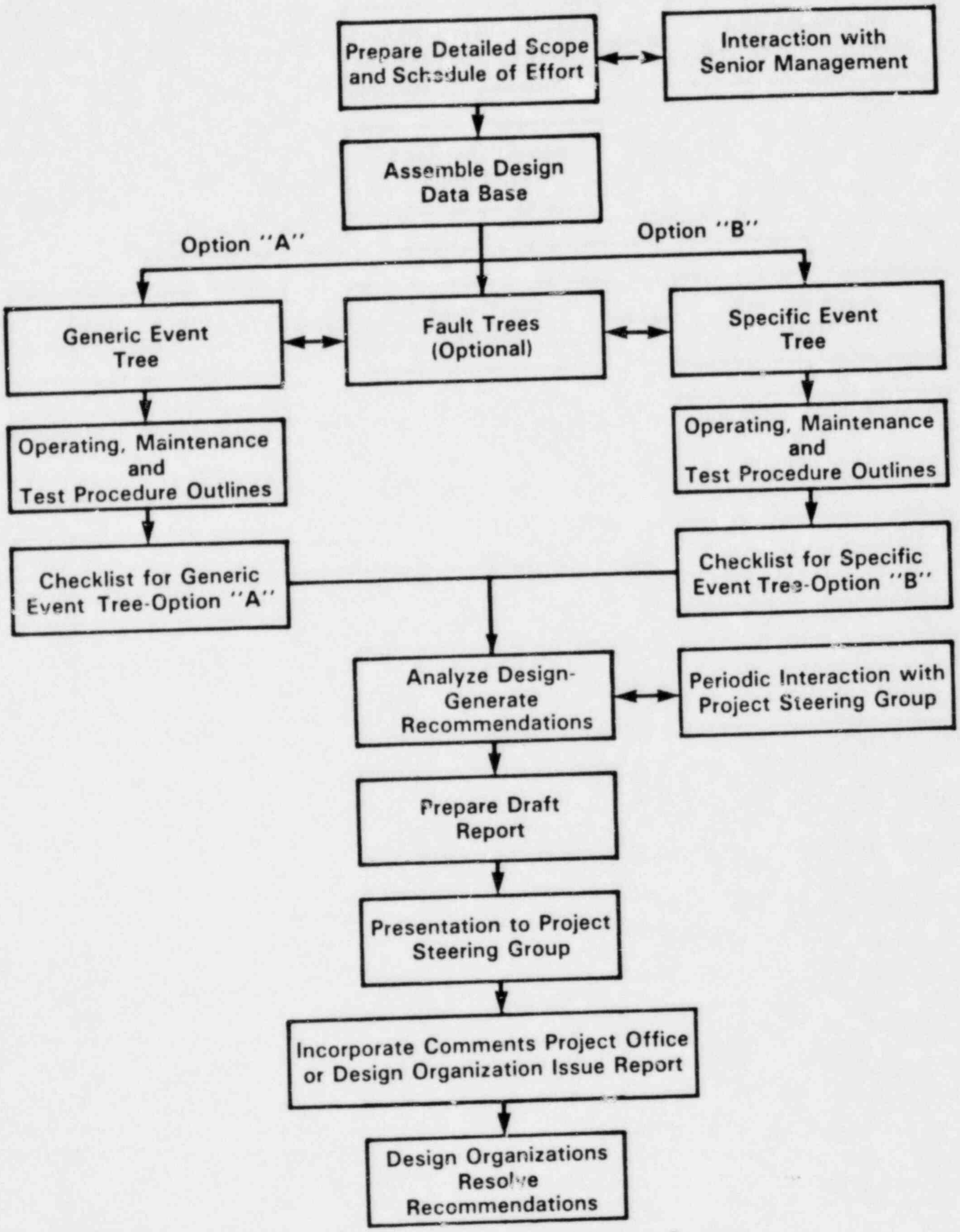


Figure II-4-1 Flow Chart of Review Process

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A Project Steering Group was established which provided initial guidance on the conduct of the reviews, provided overall direction to the review teams, and conducted periodic reviews with the team members. The Project Steering Group consisted of senior technical and management personnel with diverse backgrounds and experience.

The use of the Project Steering Group provided the expertise and overview necessary to integrate the overall efforts of the individual task teams with respect to the overall performance of the plant systems on an integrated basis.

Each of the review teams developed a detailed scope of work and schedule for completion. This detailed scope of work was developed at team meetings where a detailed understanding of each individual's responsibility was developed. In addition, a schedule consistent with the scope of work and methodology was developed. This scope and schedule was reviewed with the Project Steering Group and, if appropriate, modified to reflect the interaction.

Once the scope and schedule were established, the team began gathering the design data base information that was to be used for the evaluation of the systems encompassing the reviews. This data base was assembled to ensure that the subsequent efforts reflected the approved design (baseline documents).

With the data base assembled, the teams proceeded to develop the tools necessary to complete the assessment of the design. The fundamental approach used by most teams was to construct event/fault trees that represented the systems/components in the plant design that were necessary to perform the review topic function, (e.g. decay heat removal).

The review evaluation of the system response was completed with the review (where available) or construction of Operation, Maintenance and Test (OMT) procedure outlines and preparation of detailed checklists. The OMT procedure outline's were used to identify the automatic and/or operator action required to detect, isolate and recover from the postulated failures. The review concentrated on the adequacy of the information provided to the Control Room Operator (CRO). Checklists were utilized in conjunction with the event/fault trees and OMT procedure outline to maintain a rigorous systematic review process.

c. **Products** - The teams had periodic interaction at approximately 4-6 week intervals, with the Project Steering Group. At the conclusion of the review process, each team prepared a draft of the final report that was submitted to the Project Steering Group for review. The report contained the following information:

- Description of the problem and recommendations for solution
- Description of methods used in the analysis
- Results
- References to documentation used in the review that included the baseline data and data generated in lieu of an established baseline
- OMT procedure outlines generated for the review

Approximately 2-4 weeks after the draft report was submitted, each team made oral presentations of the review to the Project Steering Group. The team members participated in both the presentation and discussion of the problems and recommendations. The interchange with the Project Steering Group resulted, in some cases, in modifications, additions or deletions to the list of team recommendations. The task team final report was modified, as appropriate, to incorporate the interchange comments.

d. **Feedback to the Design** - The final report for each of the key system reviews was issued to the Project design organization for resolution of the task team recommendations. The resolution of the task team recommendations was assigned in the following manner:

1. The recommendation was assigned to the design organization responsible for system design which was related to the recommendation.
2. A commitment number and date for resolution was established in a computerized tracking system.
3. The resolution for all of the recommendations was required to be formally transmitted to the CRBRP Project Office.

The recommendations from the various task teams can be categorized into several broad areas; namely,

1. Procedure related
2. Interface inconsistencies
3. PSAR inconsistencies with design
4. Man-machine interfaces
5. Design improvements
6. Analysis required
7. Economic factors
8. Miscellaneous

The majority of the task team recommendations were related to the procedures and man-machine interfaces.

e. **Responsibility and Authority** - The review teams were responsible for the conduct of the review with periodic reporting to Project Senior Management with the composition of both groups composed of CRBRP personnel or outside consultants as necessary.

   The resolution of the recommendations is accomplished in several ways by the responsible design organization; namely,

   1. Incorporate an engineering change into the baseline design documentation via established Project procedures.

   2. Reject the recommendation with adequate technical justification subject to senior management approval.

   3. Perform additional systems analyses to support current baseline design.

   4. Incorporate information into unbaselined documentation, e.g. procedure outlines, via established Project procedures.

   5. Modify the PSAR.

f. **Schedule** - All reviews have been completed with the exception of the Class 1E and non-1E

Electrical Power Distribution and I&C review which will be completed in mid-1983. The recommendations made by the reviews that have been completed were entered into a computerized tracking system and a significant fraction of the recommendations have been resolved.

5. Systems Interaction Analysis

a. **Objective** - The objective of the Systems Interaction Analysis is to produce a quantitative availability assessment of the CRBRP that will establish a plant capacity factor with a high degree of confidence and identify areas where the plants availability may be enhanced.

The analysis assesses the availability of the plant to produce and export electrical power at 100% rated capacity and is performed for all systems essential to the production of power and critical to plant safety.

b. **Description** - The availability of the CRBRP is assessed by formulation of a functoinal flow diagram; definition of system functions; development of availability block diagrams and assessment of each system using AVPROG computer code simulation. An assessment of overall plant availability will then be made.

The CRBRP functional flow diagram has been established by the review of the functions of the CRBRP systems and their interfaces to determine series and parallel interconnections and system interdependencies.

Definition of system functions has been formulated by study of the plant and system design descriptions. These definitions include a statement of the functions the systems perform, any interfaces with other systems, and provide a list of line replaceable units included in each system.

The system availability block diagrams consider the failure modes that can prevent successful performance of system function. They include the Mean Time Between Failure (MTBF) and Mean Time to Repair (MTTR) for the failure modes of each Line Replaceable Unit (LRU).

AVPROG is an event driven direct-analog program designed to operate through several cycles of simulated operation processing the data input from the availability block diagrams and calculating the availability of the system or plant.

c. **Products** - The results of the Systems Interactive Analysis will be documented as follows:

System Assessment Reports consisting of system functions descriptions, availability block diagrams, assessment results and recommendations.

Plant Assessment Report consisting of the CRBRP functional flow diagram, assessment results and recommendations.

System Action Memorandum describing problems and possible improvements to systems availability that are recognized as a result of the analyses.

d. **Feedback to the Design** - Prime objectives of the Systems Interactive Analysis are to identify design deficiencies, detrimental redundancies and areas where the availability of the plant may be enhanced. Accordingly the analyses are transmitted to the system designers for review and evaluation of deficiencies and potential improvements. Where changes are required to correct problem areas or affect significant improvements in availability, they will be submitted through the established project engineering change notice proposal process.

e. **Responsibility and Authority** - A "CRBRP Systems Interactive Analysis Steering Committee" was established that is composed of senior members of the Project Office Engineering and Public Safety staffs, plus the Resident Manager at Oak Ridge from Burns and Roe, and chaired by the Technical Director of Westinghouse at Oak Ridge. This committee provides direction to the program prioritizing the systems to be assessed, and approving goals, overall approach schedule and costs.

The Westinghouse Manager of Design Control has been delegated the responsibility for management of the contractor's performance of the program. All technical direction, review and approval of the contractor's work is provided through this group.

f. **Schedule** - The schedule for completion of the Systems Interactive Analysis is currently September 1983; however, due to additional work that is being considered to enhance the accuracy of the analyses, the work is not expected to be completed until March 1984.

At this time, assessments have been completed for the following systems:

- Power Transmission System
- Primary Heat Transport System
- Intermediate Heat Transport System
- Steam Generator Auxiliary Heat Removal System
- Steam Generator System
- Reactor Heat Transport Instrumentation System

The Systems Interactive Analysis will include assessments for the following systems in addition to those currently completed:

- Building Electrical Power System
- Compressed Gas System
- Chilled Water System
- Nuclear Island Heating, Ventilating, and Air Conditioning System
- Sodium Fire Protection System
- Reactor Containment System
- Recirculating Gas Cooling System
- Reactor System
- Reactor Enclosure System
- Reactor Refueling System
- Nuclear Island General Purpose Maintenance Equipment System
- Balance of Plant General Purpose Maintenance System

- Liquid Metal to Gas Leak Detection Instrumentation System
- Piping and Equipment Electrical Heating and Control System
- Balance of Plant Instrumentation and Control System
- Feedwater and Condensate System
- Main and Auxiliary Steam System
- Heat Rejection System
- River Water Service System
- Plant Service Water System
- Treated Water System
- Auxiliary Liquid Metal System
- Inert Gas Receiving and Processing System
- Impurity Monitoring and Analysis System
- Plant Control System
- Reactor and Vessel Instrumentation System
- Fuel Failure Monitoring System
- Flux Monitoring System
- Radiation Monitoring System
- Plant Protection System

6. <u>Equipment Testing</u>

a. **Objective** - Although the many test programs for CRBRP equipment development, qualification, acceptance, pre-operation, and startup do not demonstrate reliability in a statistical sense, they do contribute significantly to assurance of reliable plant systems operation and performance. Selected safety system tests have been designed to explore equipment performance margins and extended limits of operation in a qualitative reliability sense.

b. **Description** - The development test programs of primary interest to safety-related reliability are:

- Plant Protection System
- Primary and Secondary Shutdown Systems
- Main Sodium Pump/Drives
- Steam Generators
- EM Pumps
- Small Liquid Metal Valves
- Control Room Mock-up

Emphasis is on first-of-a-kind components. Early in the program preliminary failure modes and effects analysis supported definition of these test programs. Tests were designed to evaluate the equipments resistance to the failure modes and mechanisms identified by analysis. The tests are providing data, though seldom statistically meaningful, that support the reliability assessment programs. When large numbers of tests are possible, such as individual control rod insertions, the data allows some limited evaluations of statistical meaning and demonstration of reliability. The PSAR provides test program details for the systems of primary interest to the safety-related reliability program in Appendix C. Appendix C discussions of test programs are oriented to the reliability assurance function, however, since these tests are primarily development and performance verification tests to provide essential design development data they also are discussed throughout the PSAR in sections devoted to the particular equipments.

c. **Products** - Test Reports are prepared by the test performer for each test program.

d. **Feedback to the Design** - The cognizant design engineering organization for the equipment under test is the test requestor. The purpose of the development test program is feedback of test data for confirmation of an adequate design. Test failures, if they occur, require failure analysis and corrective action to satisfy the success criteria established and approved by Project management prior to test program authorization.

e. **Responsibility and Authority** - The design organization test requestor prepares a

Development Requirement Specification (DRS) that details direction to the performer organization. The DRS includes appropriate criteria to be used to determine the success or failure of the development results. The DRS is approved by the requestor organizations responsible engineer, QA, and engineering line management as specified by the internal procedure. The Lead Reactor Manufacturer or the CRBRP Project Office may exercise the option to comment on, or approve selected final DRS's even though Approval in Principle of the Development Activity Description (DAD) by these organizations was prerequisite to DRS preparation.

f. **Schedule** - Equipment testing schedules are too numerous for listing here but are generally discussed throughout the PSAR. Testing activity started early in the CRBRP project and will continue during the design development phase of the program through plant start-up.

7. Equipment Qualification

a. **Objective** - The equipment qualification program objective is to ensure that safety related equipment included in the plant can perform its intended safety functions under the anticipated service conditions in which it is required to do so.

b. **Description** - A program has been established which delineates equipment to be qualified, the service conditions to be qualified for, the engineering criteria, the qualification analysis and testing to be conducted, and the documentation and record keeping requirements. This program is documented in WARD-D-0165, "CRBRP; Requirements for Environmental Qualification of Class 1E Equipment". The requirements for qualification of mechanical equipment will be defined in the equipment specifications.

The 1E program conforms to the criteria and requirements established by the NRC through NUREG-0588, "Interim Staff Position on Environmental Qualification of Safety Related Electrical Equipment", and by the nuclear industry through IEEE Standard 323, "IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations". The requirements of the program are incorporated into the Engineering Specifications of all safety related electrical equipment and are contractually enforced in all procurements. The safety related equipment environmental qualification program is defined in the PSAR Section 3.11.1.

c. **Products** - Safety related equipment is environmentally qualified to perform its intended safety function, and documentation and records are provided to verify the qualification.

d. **Feedback to Design** - The design can confidently assume that safety related equipment will not fail as a result of exposure to environmental conditions anticipated through the equipments service life.

e. **Responsibility and Authority** - The Assistant Project Director for Engineering has overall ultimate responsibility and authority for the execution of the program.

   The Manager, Systems Integration, Westinghouse Oak Ridge has been delegated the responsibility for technical management of the environmental qualification program requirements.

f. **Schedule** - The program is in effect from beginning of procurement of safety related electrical equipment through the service life of the plant. All original and all replacements and spare equipment covered by the program must conform to it.

8. Failure Evaluation

a. **Objective** - Procedures have been established for CRBRP to provide assurance that the cause and mode of each failure is determined, that the potential safety and availability implicatons are evaluated, and that corrective action is taken.

b. **Description** - A "failure" is defined as the "inability of a system, subsystem, or unit to perform its required function within specified limits for specified durations". Each performer of development activities has established and implemented procedures for reporting, analyzing and correcting failures.

c. **Products** - Failure evaluation reports and data are available for review by customer organizations and the conditions and their status of corrective action are reported in the Project's monthly Quality Status Reports when such reports are required.

d. **Feedback to the Design** - Each performer of development activities maintains a log of failures occurring in his program. The log includes an identification of the occurrence, its disposition, and a determination that the action required by disposition is complete.

e. **Responsibility and Authority** - Ultimate responsibility and authority for the failure evaluation program resides with the Assistant Project Director for Quality Assurance. Pursuant to the requirements established in contracts the responsibility for performance of the failure evaluation program is delegated contractually to each equipment supplier. Each performer of development activities is responsible for failure evaluations. The contractual responsibility for concurrence with corrective actions ascends through all contractual levels from the performer to the Assistant Project Director for Quality Assurance, Engineering, and Public Safety.

f. **Schedule** - Individual failure evaluation schedules are established and maintained in the performer's log and are contingent on the individual circumstances involved.

III. Quality Assurance Activities

A. Quality program

The ultimate quality of the plant will be the result of two basic functional processes, one which may be characterized as an "achieving" process and the other as an "assuring" process. The "achieving" functions are those work activities associated with planning, designing, manufacturing, constructing, and operating. The "assuring" functions are those work activities associated with planning, controlling, inspecting, testing, surveillance, auditing and recording. Within this combination of efforts, the overall quality of the plant is attained by all those work activities of an "achieving" nature with achievement assured through all those activities of an "assurance" nature. This latter function is the quality assurance function.

> Quality Assurance "All those planned and systemmatic actions necessary to provide adequate confidence that an item will perform satisfactorily in service."

Determining and specifying the quality requirements of the plant are engineering functions accomplished through planning and design. These requirements are defined through development of criteria, application of codes and standards, and the preparation of descriptions, drawings, specifications, procedures and instructions. The conversion of these plans and specifications into structures, systems, and components of the plant is accomplished during manufacturing and construction. These activities constitute the overall project work program, and these activities will be carried out by the participating project organizations.

The quality assurance program parallels the work program and acts to assure that quality is achieved through the work program.

> <u>Quality Assurance Program</u> "The overall integrated practice established and implemented to assure quality achievement."

The Project's quality assurance program, comprised of the quality assurance functions, is made up of two basic types of achievements. These may be categorized as programmatic practices and work oriented practices.

The programmatic practices encompass the activities of:

Program Management
Design Control
Procurement Control
Manufacturing and Construction Control
Operation Control.

The work oriented practices encompass the activities of:

Inspection
Examination
Testing

B. <u>Objectives</u>

The Project's quality assurance program objectives are as follows:

1. To assure the attainment of the level of quality necessary for the accomplishment of Project objectives commensurate with the Owner's responsibility for protection of the public health and safety, for the protection of the environment, and for reliable plant operation.

2. To assure that facilities, systems, components and equipment designed, procured, fabricated, installed, constructed, tested, operated on modified by or for the Owner conform to specified requirements.

3. To assure that appropriate quality assurance activities are implemented by and for the Owner.

C. Requirements

The Project's overall quality assurance program covers the entire CRBRP. Each Project participant has a part in this program commensurate with his scope of Project participation. Each participant's part of the program is defined and implemented and interfaces with his customer or his subcontractors or both to achieve maximum efficiency and required effectiveness.

The requirements for the Project's overall quality assurance program are contained in Section 17 of the PSAR, "Quality Assurance Program Requirements," and are compatible with other nationally recognized codes and standards. The application of these requirements is described in the overall plant design description, the plant system design descriptions and the appropriate contractual documents for items and services.

D. Elements

The major elements of the Project's overall quality assurance program have been identified as shown in Figure III-1. These have been grouped by Project phase or function in which they occur or to which they relate. Each major program participant has been assigned the appropriate program elements that must be executed either internally by him or by further delegation to his lower tier (first level) participants. It should be pointed out that these elements are programmatic or management system type activities and should not be interpreted as containing all the detailed work practice oriented activities for performing such things as special process controls or specific methods of inspection, examination, or testing. A detailed description of the CRBRP Quality Assurance Program is presented in Chapter 17 of the PSAR.

OVERALL PROGRAM

Polic-
Objectives
Responsibility
Requirements
Surveillance

ARD

PROGRAM MANAGEMENT

QUALITY ASSURANCE PROGRAM
1) Planning
2) Quality Assurance Index

ORGANIZATION
1) Responsibility & Authority
2) Training & Indoctrination
3) Personnel Qualification

DOCUMENTATION
1) Policies & Procedures
2) Quality Records
3) Quality Status Reports

AUDITS AND REVIEWS
1) Quality Audit
2) Management Reviews

CORRECTIVE ACTION

ENGINEERING HOLDS

ARD ARD ARD ARD ARD

Design and Development

DESIGN PLANNING

DESIGN DEFINITION AND CONTROL
1. Design Criteria
2. Codes, Standards and Practices
3. Engineering Studies
4. Parts, Materials and Processes
5. Design Descriptions
6. Specifications, Drawings and Instructions
7. Identification
8. Acceptance Criteria
9. Interface Control

DOCUMENT REVIEW AND CONTROL
1. Document Reviews
2. Document Control
3. Engineering Drawing Lists

DESIGN REVIEWS

DEVELOPMENT

FAILURE REPORTING AND CORRECTIVE ACTION

Procurement

PROCUREMENT PLANNING

PROCUREMENT REQUIREMENTS

PROCUREMENT DOCUMENT REVIEW

EVALUATION AND SELECTION OF PROCUREMENT SOURCES
1. General Requirements
2. Acceptable Source List
3. Preaward Evaluation
4. Interchange of Source Capability Information

CONTROL OF CONFIGURATION
1. Contract Change Control
2. As-Built Verification

EQUIPMENT CALIBRATION AND STANDARDS

SOURCE SURVEILLANCE AND INSPECTION

RECEIVING INSPECTION
1. Planning and Inspection
2. Documentation
3. Disposition of Received Items

CONTROL OF NONCONFORMING ITEMS

CONTROL OF RECIEVED ITEMS

Manufacturing, Fabrication, and Assembly

PLANNING

INSPECTION AND LIST PLAN

MATERIAL, IDENTIFICATION AND CONTROL

CONTROL OF PROCESSES
1. Fabrication and Assembly Processes
2. Process Qualification
3. Nondestructive Examination
4. Cleaning

INSPECTION AND TESTS
1. General Requirements
2. Procedures
3. Completed Item Inspection and Test
4. Inspection Status Indication
5. Certification

DOCUMENT CONTROL

EQUIPMENT CALIBRATION AND STANDARDS
1. Equipment Evaluation
2. Control of Inspection Measuring and Test Equipment
3. Calibration Standards
4. Discrepant Equipment

STATISTICAL QUALITY CONTROL AND ANALYSIS

CONTROL OF NONCONFORMING ITEMS

CORRECTIVE ACTION

HANDLING, PRESERVATION, PACKAGING, STORAGE, AND SHIPPING
1. Handling
2. Preservation, Packaging, and Storage
3. Shipping

Construction and Installation

ORGANIZATION

CONTRACT

CONSTRUCTION PLANNING

CONTROL OF CONFIGURATION

CONSTRUCTION PROCUREMENT

CONSTRUCTION AND INSTALLATION CONTROL
1. Material, Handling and Cleaning Control
2. Special-Process Control
3. Training and Certification
4. Interface Control
5. Equipment Calibration and Standards
6. Control of Nonconforming Items
7. Statistical Quality Control and Analysis

INSPECTION
1. Source Inspection
2. Receiving Inspection
3. Site Inspection
4. Installation Inspection

TESTING, OPERATION, AND MAINTENANCE
1. Start-up of Equipment and Systems
2. Preoperation Testing
3. Operation and Maintenance

Operation, Maintenance, and Modification

OPERATION, MAINTENANCE AND MODIFICATION

PLANNING

ORGANIZATION
1. Responsibility and Authority
2. Training and Certification

OPERATION CONTROL
1. Operating Objectives
2. Procedures
3. As-Built Verification
4. Technical Specifications
5. Document Control
6. Operation Reviews

MAINTENANCE CONTROL
1. Maintenance Policy
2. Work Instructions
3. Special Processes
4. Parts and Materials
5. Documents
6. Maintenance Review

MODIFICATIONS

SURVEILLANCE

INSPECTION AND TESTING

EQUIPMENT CALIBRATION AND STANDARDS

INCIDENT REPORTING AND CORRECTIVE ACTION

Figure III-1