Safety Evaluation Report

NUREG-0061
Suppl. 1

U. S. Nuclear
Regulatory Commission

related to operation of

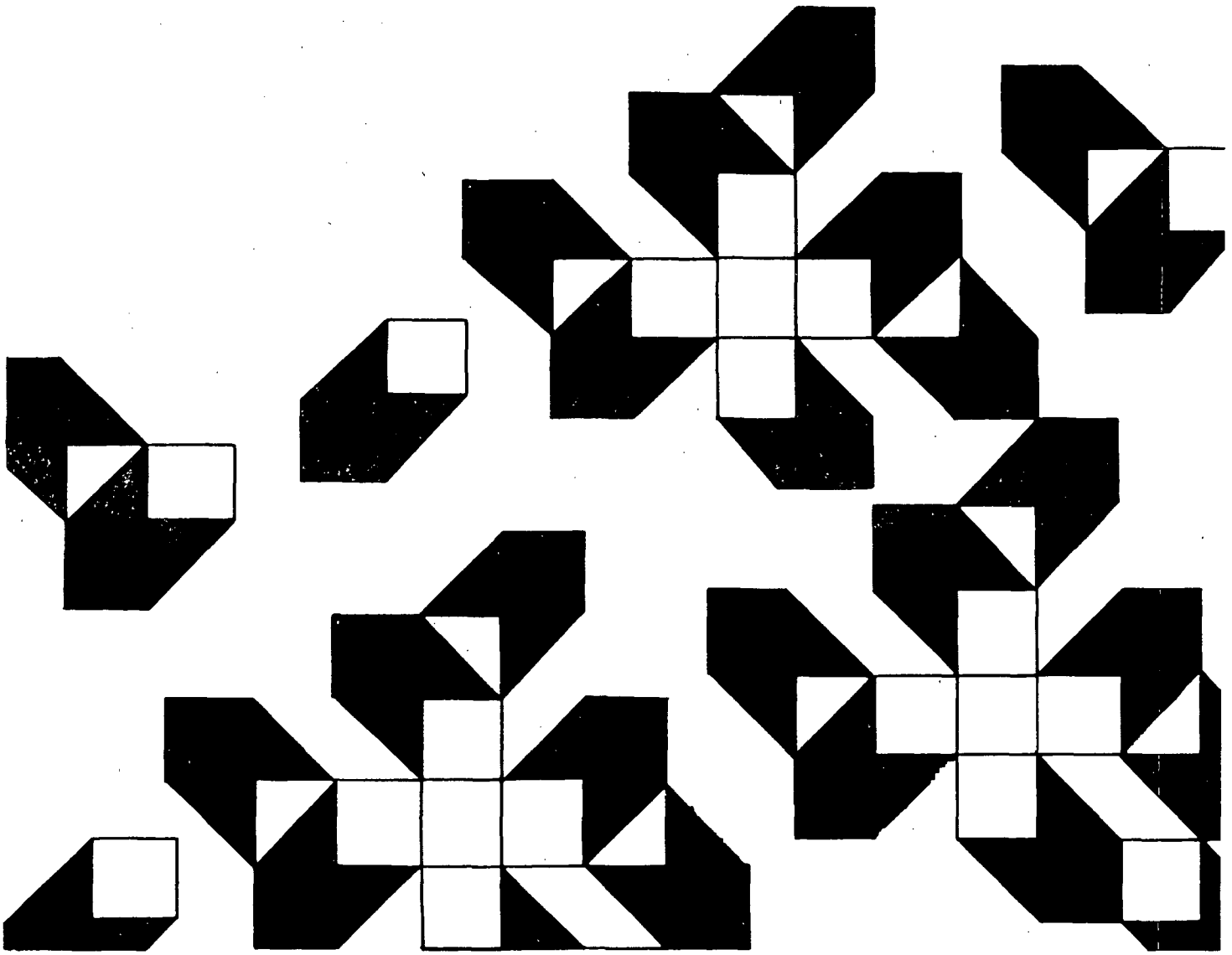
Browns Ferry, Units 1 and 2

Following the March 22, 1975 Fire

Office of Nuclear
Reactor Regulation

Division of
Operating Reactors

June 1976



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SUPPLEMENT NO. 1

TO THE

SAFETY EVALUATION

BY THE

DIVISION OF OPERATING REACTORS

SUPPORTING THE OPERATION AFTER THE

RESTORATION AND MODIFICATION OF THE

BROWNS FERRY NUCLEAR PLANT, UNITS 1 AND 2

FOLLOWING THE MARCH 22, 1975 FIRE

DATE: JUN 18 1976

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1.0 Introduction

The Safety Evaluation Report by the Division of Operating Reactors Supporting the Operation After the Restoration and Modification of the Browns Ferry Nuclear Plant Units 1 and 2 Following the March 22, 1975 Fire (SER) was issued on February 23, 1976. The SER identified matters requiring additional submittals by the Tennessee Valley Authority (TVA) with subsequent NRC evaluation. Since the date of the SER issuance, there have been meetings with TVA, additional revisions to the "Plan for Evaluation, Repair and Return to Service of Browns Ferry Units 1 and 2 (March 22, 1975 Fire)" dated April 13, 1975 (the Plan), and meetings with the ACRS resulting in an ACRS report dated March 11, 1976.

The purpose of this supplement is to update the SER based on the NRC evaluation work performed since February 23, 1976. The section numbers of this supplement are the section numbers of the SER wherein the matter was identified except for Sections 11, 12, 13, 14, 15 and 16. Section 11 discusses ACRS items which were identified for additional information or evaluation in the ACRS report dated March 11, 1976. Sections 12 through 16 are new sections. In addition, the supplement contains an updated chronology as Appendix A, the report of the Advisory Committee on Reactor Safeguards (ACRS) as Appendix B, a report by the Analytical Research Laboratories, Inc. on combustion test results for Flamemastic 71A as Appendix C, and a comparison of the Browns Ferry Plant with the "Recommendations Related to Browns Ferry Fire, Report by Special Review Group" (NUREG-0050) as Appendix D.

2.4.1 Stainless Steel Piping and Tubing and Surveillance Programs

We have evaluated the additional metallographic and surface replication test results provided by TVA. These results have confirmed our findings that TVA has conducted an adequate program of investigation of the effects of soot contamination, component cleaning, cleanliness verification, evaluation and testing.

The initial sampling program of stainless steel piping and piping components exposed to the fire residues disclosed only one sample that had indications of stress corrosion cracking initiation. This sample was a 1/4 inch diameter thin wall tube. To determine the extent of corrosion on the small instrument lines, TVA removed at least one tube sample from each of the critical instrument panels. Six of the samples were found to have indications of the initiation phase of stress corrosion cracking.

The instances of corrosion displayed a general pattern that indicated that a major concentration of fire residue had moved from the fire area and proceeded around the west side of the drywell to a stairwell in the southwest corner of the reactor building. All the affected panels were along the residue path to the stairwell or adjacent to the stairwell on lower elevations. In the six panels in which corroded tubes were observed, all the instruments were retubed. In addition, instruments in three other panels adjacent to the six affected ones were also retubed.

None of the other sampled panels were located in the path of the residue and none had signs of corrosion. The sampling program will be continued so that a sample tube will be removed for evaluation from each of these remaining unretubed critical panels during the first refueling outage of Unit 1 and again during the fourth refueling outage. This is in addition to the visual surveillance that these lines will receive. We find TVA's instrument line sampling, testing, replacement and surveillance programs to be satisfactory.

In the SER, we stated that we were in basic agreement with TVA's surveillance program approach, but would evaluate the need for an increased scope and longer period of surveillance. As a result of our review, the surveillance program to be set forth in the Technical Specifications has been extended through the fifth refueling outage. At each refueling outage, prior to the fifth, penetrant examination will be performed on the stainless steel piping and components on a sampling basis in accordance with Browns Ferry Mechanical Maintenance Instruction Number 53. During the fifth refueling the penetrant examination will have the same scope as the examination performed to qualify the plant to return to power according to Browns Ferry Mechanical Maintenance Instruction Number 46. Reports of

results of these examinations will be submitted to NRC. We conclude that this program will provide adequate assurance that any deleterious effects of residual chlorides will be detected prior to causing a safety hazard.

2.4.2 Encapsulation of Fire Residue in Cable Trays

In Revision 38 to the Plan, TVA reported that cleaning of the fire residue from cables in cable trays was found to be impractical because the large number of cables in the tray and the short intervals between tie-down points precluded access. In addition, the use of steam cleaning or high velocity sprays would have led to recontamination of the reactor building and possible damage to cables.

The encapsulation action of the Flamemastic coating provides an effective barrier to any transport of possible chloride residue from the tray area to other parts of the reactor building. This is the most important consideration, since the greatest concern is the effect of chlorides on primary coolant system piping and tubing.

We have evaluated any possible adverse effects due to residual chlorides that might remain in the cable trays. The PVC cables themselves would be uneffected by any chlorides present. The Flamemastic coating limits the moisture ingress thereby minimizing the possibility of corrosion on the trays and supports. Any corrosion or rusting would be inhibited by the chemical neutralizing action of the calcium carbonate content of the Flamemastic. The electrical cables, cable trays, and supports would not be adversely affected by the products of the neutralizing actions of the Flamemastic.

Further, all cable trays and supports will be inspected annually for five years for indication of degradation of the cable tray systems. If degradation of the trays and supports are found, they will be replaced. In addition, at the first and second refueling outages of Unit 1 and at approximately every three years thereafter, a cable tray on elevation 593 ft. in Unit 1 that has fire residue in the cable bundle shall have a portion of the Flamemastic cocoon opened and the cables and Flamemastic inspected for any signs of deterioration.

We conclude that encapsulation of the chloride containing residue within the cable trays by the Flamemastic coating provides reasonable assurance against any adverse affects of the residue so contained and that the surveillance of cable trays, cable tray supports, and cables will ensure that any degradation of the components will be detected and corrected, if found, prior to causing a safety hazard.

6.2 Procedures (Fire-related)

In Section 6.2 of the SER we stated a concern regarding the development of procedures for assessing transient fire loads in critical areas of the plant and the additional fire protection requirements that may be required, if any. Our specific concern related to taking credit for fire protection systems installed to protect critical systems or cabling in the transient fire load procedure. We further stated that we would require a continuous fire watch with charged fire hose where transient fire loads could be located in critical areas where, due to obstructions, the installed fire protection system may not be effective for the transient fire load.

TVA has proposed a procedure for control of transient fire loads at nuclear plants in Revision 43, Part XII of the Plan. The criteria set forth in these proposed guides for the procedure which are now required by the Technical Specifications remove our concern in that no credit will be taken for fixed fire water spray or sprinkler systems in regard to extinguishing capability for transient fire loads. Another section of the procedure specifies the fire load limits and when additional fire protection methods must be provided with relation to these limits. The procedure further requires a periodic inspection of the area for low loads and a continuous fire watch for medium and high fire loads.

Our requirement as stated in the SER included the need for charged fire hoses in the area of the transient fire loads. Based on our evaluation of the transient fire load procedure we find that the charged fire hose requirement is not necessary but that the hoses be laid out, if required. The charged hose does represent a personnel safety hazard. The valves that are used to charge the fire hose are located at the hose rack or reel and are quickly accessible by the fire watch that would be stationed in the area.

Therefore, based upon a determination by the Office of Inspection and Enforcement (OI&E) that TVA has established procedures that fully conform to the criteria set forth in Revision 43, Part XII of the Plan, we concluded that our concern and requirements stated in the SER have been resolved.

6.4 Quality Assurance

General

The description of the quality assurance (QA) program for the Browns Ferry Nuclear Plant, Units No. 1 & 2 for the operation phase is contained in Appendix D of the Final Safety Analysis Report (FSAR) through Amendment 62 and in the docketed J. E. Gilleland's letter to B. C. Rusche dated June 7, 1976. This letter commits TVA to interpret the "shoulds" contained in the ANSI standards referenced in the QA programs as requirements and will be implemented accordingly. Our evaluation of the QA program is based on a review of this information and discussions with Tennessee Valley Authority (TVA) personnel to determine that the QA program meets with the requirements of Appendix B to 10 CFR Part 50 and the acceptance criteria described in Section 17.2, "Quality Assurance During the Operating Phase," of the Standard Review Plan.

The QA program for the restoration of the damaged facilities at the Browns Ferry Plant is described in the Browns Ferry Recovery Plan Part XIII. This program contains additional controls especially in the areas of design, procurement, installation and inspection associated with the restoration phase beyond those in the QA program prior to March 1975. These additional controls and requirements are contained in WASH documents 1284 "Guidance on Qality Assurance During the Operations Phase of Nuclear Power Plants," 1309 "Guidance on Quality Assurance Requirements During the Construction Phase of Nuclear Power Plant," and 1283 "Guidance on Quality Assurance Requirements During the Construction Phase of Nuclear Power Plants." We find that this QA program is acceptable and satisfactorily addresses each of the criteria of Appendix B to 10 CFR Part 50.

Organization

The Office of Power has overall responsibility for the TVA power program, and the Manager of Power who heads the Office of Power has responsibility for the implementation and effectiveness of the QA program for operations. Figure 17.2-1 shows the TVA organizations which directly affect the QA program for the operations phase.

Reporting to the Manager of Power is the QA Manager who is responsible for establishing and controlling the QA program manual, assuring its implementation, measuring its effectiveness through audits, documenting and reporting deficiencies, verifying effective corrective action, developing and coordinating QA training programs and keeping upper management abreast of quality problems. The onsite QA coordinators, reporting independent of plant supervision, to the QA Manager, have primary responsibility for monitoring and evaluating the implementation and effectiveness of the onsite QA program. When quality assurance problems are identified (such as through the onsite QA coordinator), the QA Manager has the responsibility and authority to initiate the appropriate corrective action, including that necessary to stop work through appropriate managerial action, when manufacturing, maintenance, repair, refueling, operator or modification work fails to comply with approved specifications and plans.

The primary responsibility and authority for reactor operation and safety of Browns Ferry is vested in the Power Plant Superintendent. Inplant QA and quality control (QC) are his responsibilities. The supervisor of the Plant QA staff is at the same organizational level but independent from the Supervisor for Plant Operations who is directly responsible for maintenance, operations, and engineering. Both supervisors report directly to the Power Plant Superintendent. The QA staff supervisor has the responsibility for developing, planning, initiating, and directing a comprehensive QA/QC program which implements the Office of Power QA program. He also reviews the plant procedures and instructions and signs them off prior to their use, attesting that they contain the necessary QA requirements. Further, his responsibilities include developing and implementing an inspection program covering operations, maintenance, repairs, and testing of safety-related items.

When QA problems are identified, the QA staff supervisor has the responsibility and authority to initiate corrective action, including that necessary to stop work through the Power Plant Superintendent when manufacturing, maintenance, repair, refueling, operation, or modification activities fail to comply with approved specifications and plans. Should the plant superintendent fail to follow the recommendations of the plant QA staff supervisor, the supervisor has the authority to report directly to the Nuclear Generation Branch Chief to whom the Power Plant Superintendent reports.

We find that there are sufficient responsibilities delegated to the QA organization to assure that the QA program can be carried out effectively in accordance with controlled procedures without undue influence from other groups.

Quality Assurance Program

The Office of Power Quality Assurance Manual, prepared and controlled by the QA Manager, sets forth the QA policies and requirements on how each of the eighteen criteria of Appendix B to 10 CFR Part 50 are to be followed by each division. From this manual, the Division of Power Production is guided in structuring their detailed QA operating control procedures forming the basis for their Operational Quality Assurance Manual. The Browns Ferry QA program has been upgraded to include those controls (with acceptable exceptions) described in Regulatory Guides and ANSI standards provided in WASH document 1284 (Orange Book), "Guidance on Quality Assurance During the Operations Phase of Nuclear Power Plants," dated October 26, 1973; WASH document 1309 (Green Book), "Guidance on Quality Assurance Requirements During the Construction Phase of Nuclear Power Plants," dated May 10, 1974; and WASH document 1283 - Revision 1 (Gray Book), "Guidance on Quality Assurance Requirements During Design and Procurement Phase of Nuclear Power Plants," dated May 24, 1974. These QA provisions are in such areas as design control, procurement control, qualifications of inspection, examination and testing personnel and controls for the installation, inspection and testing of instrumentation and electric equipment. These additional requirements and controls, which were not previously addressed in the QA program, provide further definition on the implementation of important elements of Appendix B to 10 CFR Part 50. This upgraded QA program is extended to cover the installation, testing, surveillance testing and administrative controls for the fire prevention and protection program and equipment for safety-related areas during the operational phase.

The Browns Ferry program provides for routine inservice and installation inspection of safety-related structures, systems, and components in accordance with preestablished and approved procedures, instructions, or checklists which identify the operation or characteristics to be inspected and the accept/reject criteria, and also provides for documenting the inspection results. The QA program requires that personnel performing the inspection activity be independent of the individual or group that performed the work being inspected. The program provides for the identification of material, equipment, and parts throughout receipt, installation, operation, maintenance, modification and refueling phases which indicates their inspection, test, and operating status. Nonconforming items are controlled under the QA program. TVA's QA Manager is responsible to establish procedures for retention and storage of the QA records.

A system of planned and documented audits, described in the FSAR, will be used by TVA to verify compliance with all aspects of the QA program and to assess its effectiveness. The QA Manager is responsible for the audit system. In addition, the Manager of Power requires an independent review of the Office of Power QA program to be performed every two years to evaluate its overall effectiveness and identify any weaknesses.

Conclusion

Our review of the Browns Ferry QA program description for the operations phase has verified that all applicable requirements of Appendix B to 10 CFR Part 50 are included in the QA program requirements. Further, this review has determined that the QA organizations are structured such that they can effectively carry out their responsibilities related to quality without undue influence from other groups.

Based on our detailed review and evaluation of the QA program description contained in the FSAR for Browns Ferry Nuclear Plant, Units No. 1 & 2, we conclude that:

1. The QA organization of the TVA is provided sufficient independence from cost and schedule when opposed to safety considerations, authority to effectively carry out the QA programs, and sufficient access to management at a level necessary to perform their QA functions.

2. The QA program description contains adequate QA requirements and controls which address each of the criteria of Appendix B to 10 CFR Part 50 in an acceptable manner.

Section 7.5.1 Fixed Water Systems

The hydraulic calculational methods that TVA has used in the design of the fixed water systems in the plant are not in exact conformance with the methods set forth in the NFPA Code. TVA's consultant questioned these methods and recommended that all calculations be performed by the NFPA code methods. We and our consultant have made a review of TVA's calculational methods and compared them with the NFPA code methods. One specific system which we reviewed in detail was one of the zones of the fixed deluge system being installed prior to restart. The results of this review indicate that TVA's methods are comparable to the NFPA methods and result in an adequate design. This is based on water flow and pressure being available to the system as used in the calculational methods. The preoperational testing to be performed will assure that the flows and pressures will be available. (See Section 9.1 of this report)

Therefore, based on our review of the calculational methods used and comparison with NFPA code methods, we conclude that the systems designed using TVA's methods are camparable with the NFPA code methods and are acceptable. Our concern set forth in the SER Section 7.5.1 and in Attachment 2 to the report has been resolved based on this review.

As stated in Section 6.2 of the SER, the fixed fire water system will be added to the semi-annual chemical treatment procedure, already existing for other water systems, for the control of crustacean growth in the system. This procedure also requires complete flushing of the systems up to the closed valves in the dry pipe spray systems. The chemical treatment and flushing will also remove build-up of other materials, such as sludge from the river water, to provide assurance that the systems are clean. Crustacean control is important to assure that spray nozzle performance is not degraded. TVA's experience with the control of crustacean growth in water systems at Browns Ferry has been good and therefore, by adding the fire water system to the chemical treatment procedure will provide the necessary assurance that the spray nozzles will perform as designed. We have incorporated in the Technical Specifications a surveillance requirement for the twice per year chemical treatment and system flush. In addition, the specifications also require a yearly spray header and nozzles blockage test for detection of any degradation of the headers and nozzles flow paths.

7.5.2 & 3 Heat and Smoke Detection Systems

Section 7.5.2 and 7.5.3 of the staff's SER stated that the designs for the heat detection and the smoke detection systems were acceptable for restart, pending resolution of the concern raised by TVA's fire consultant (Attachment 2 to SER) regarding the design and installation meeting NFPA Class 1 requirements.

TVA has taken the following actions to show conformance with the NFPA Class 1 requirements:

1. TVA has modified the electrical power supply for the detection systems such that power is available from the offsite and onsite emergency power sources. The onsite capability exceeds NFPA Class 1 requirements.

2. TVA has installed additional detectors to improve coverage.

3. TVA has demonstrated that the installation techniques which are used at Browns Ferry are superior to the NFPA Class 1 requirements.

We have reviewed the modifications which have been made and the installation techniques which are used by TVA. As a result of this review we find that the designs meet the requirements for NFPA Class 1 systems and are, therefore, acceptable.

TVA has also committed to installing additional NFPA Class 1 supervised smoke detection systems in the general plant areas. These systems will, by definition, meet the TVA fire consultant's recommendations. However, TVA has taken exception to providing supervised smoke detection systems in place of the existing systems and TVA also takes exception to purchasing a supervised heat detection system to replace the non-supervised system they recently obtained.

The purpose of a supervisory circuit is to continuously monitor the detector circuits to detect a break or ground fault condition which prevents the required operation of the system and to detect a failure of the main power source. The design of the Class 1E onsite power system is such that the onsite power system annunciates the loss of offsite power as well as onsite power. We conclude, therefore, that the fire detection systems have adequate power supervision and TVA has satisfied the consultant's recommendations.

With regard to the detection of ground faults, TVA has demonstrated that their systems will operate in spite of the existence of a single unintentional ground. NFPA 72B specifically states that "A multiple ground condition is considered the equivalent of a short circuit fault" and "Electrical supervision of conductors for a short circuit fault is not contemplated" by the supervisory requirements. As a result we conclude that automatic ground supervision is not required at Browns Ferry and, therefore, the present and proposed designs are acceptable with respect to ground supervision.

With respect to the lack of continuous supervision for the detection of breaks in the signal circuits, TVA has pointed out that their use of less flammable electrical insulation, larger gauge wires, wire lugs, and conduit and the controlled access to the Browns Ferry site provide additional protection for the fire detection circuitry over that which is provided in a public building for systems which meet the minimum installation requirements of the NFPA standards. Therefore, TVA contends that supervision is not required in the Browns Ferry fire protection system. In considering this argument, we noted that the fire detection circuits at Browns Ferry are installed to more stringent requirements similar to reactor protection systems (which could also be exposed to open circuits) and we concluded that the fire detection circuits need not be continuously supervised for open circuits if they are subjected to periodic manual testing on the same basis as the reactor protection system (including testing after installation, modification, maintenance, or repair).

We find that the periodic testing required by the Technical Specifications will ensure adequate reliability of the smoke and heat detection systems.

Section 7.6.1 & 7.6.2 Automatic Fixed Fire Water Systems

In Sections 7.6.1 and 7.6.2 of the SER we took the position that TVA must use preaction valves for the automatic deluge and sprinkler systems that have been tested and approved by an independent laboratory to be acceptable for their intended function. In Revision 41 to Part X of the Plan TVA has revised the design criteria to include the criterion that all automatically actuated valves used in these systems will be Factory Mutual (FM) approved or Underwriters Laboratory (UL) listed.

With this revision to the design criteria for the automatic deluge and sprinkler systems, we conclude that the design criteria for these systems are acceptable. We will review the final design of these systems prior to their installation.

8.0 Technical Specifications

In Section 8.0 of the SER we stated that proposed Technical Specifications for the fire protection systems had been submitted by TVA. We stated that these specifications were currently being reviewed and final specifications would be developed prior to restart of Units 1 and 2.

We have been working with TVA to complete the Technical Specifications that will be issued with a license amendment to authorize restart of Units 1 and 2.

The new specifications incorporate limiting conditions for operation for (1) operability of the high pressure fire pumps and unit shutdown requirements if the system does not meet these limits, (2) minimum system pressure and flow limits, (3) minimum storage limits for CO_2 in the storage tank, (4) limits for CO_2 system operability and unit shutdown requirements if the system does not meet these limits, (5) limits on the minimum fire detection system operability and requirements for a fire watch if the detector system limits are not met, (6) requirements for a roving fire watch during the period between restart and the first refueling, (7) requirements for an annual independent fire protection and loss prevention inspection, (8) requirements for an inspection and audit by an outside qualified fire consultant every three years, and (9) requirements for the minimum in-plant fire protection organization and duties to be maintained.

Surveillance requirements are also incorporated in the specifications to require periodic testing and inspection of the fire protection systems and the fire detection systems that must be performed at specified time intervals to ensure that the fire protection systems are operable. The majority of the surveillance intervals are consistent with the NFPA code. The other intervals were determined based on the as-built plant systems and unique requirements for the Browns Ferry Plant.

We conclude that the Fire Protection Technical Specifications will provide for fire protection operability and maintenance to assure acceptable fire protection for plant operations.

9.1 Fire Protection Systems Preoperational Retest Program

In Section 9.1 of the SER we stated that TVA had provided retest outlines and criteria for those parts of the fire protection systems that have been modified or where additions were made to the original system. We also stated that TVA would provide a total preoperational testing program. By Revision 40 to the Plan, TVA has provided in Part XI the outline for the total preoperational program to be performed prior to restart of Units 1 and 2.

We have evaluated the retest and total preoperational testing program to determine that the fire protection systems will be thoroughly tested for the total plant. In addition, other features of the plant design that performed a fire protection function were also reviewed to assure adequate testing will be performed. The preoperational testing will demonstrate that the systems, controls and equipment required for the fire protection of the plant will meet manufacturer's operational requirements, design objectives and applicable NFPA code testing requirements. As a result of our evaluation, three items were noted as not being clearly set forth in the preoperational testing criteria. These items were discussed with TVA and we have been informed that the preoperational testing procedures have been modified to include them. These items are: 1) in conducting the yard hydrant flow and residual pressure tests for the main plant loop and the cooling tower loop, the residual pressure measurements will be taken at the first hydrant upstream of the hydrant being flow tested, 2) in addition to the stated systems within the plant where flow and pressure curves will be generated from the testing, curves will also be generated for the conditions at the top of each riser in the plant and 3) each fire hose will be tested to demonstrate flow capability. OI&E has verfied that the preoperational testing procedures were modified to include these items.

Based on our evaluation and the addition of the items described above to the testing procedures, we conclude that the retest and preoperational testing program for the fire protection features of the plant are acceptable and will form an adequate basis for future surveillance testing as required by the Technical Specifications.

9.2 Program for Component and System Retests

TVA has proposed a program for component and system retest which is described in Part XI of the Plan. The program included testing of all systems and components that: (1) sustained direct or indirect fire damage, (2) were disrupted to comply with interim license requirements, (3) were potentially damaged by cleanup and restoration work, or (4) have received significant modifications or maintenance. We have completed our review of the tests that will be conducted prior to fuel loading and the tests that will be conducted during the initial rise to full power operation. We requested that TVA conduct load discharge tests of the 250V unit batteries prior to fuel loading and TVA has conducted such tests. We now conclude that the test program proposed for Browns Ferry Units 1 and 2 is acceptable and is sufficiently comprehensive to provide assurance that systems and components that were disrupted or damaged by the fire will function in accordance with design requirements.

11.0 ACRS Items

The ACRS reviewed the proposed restoration and operational testing of Browns Ferry Nuclear Plant, Units 1 and 2, at a March 4, 1976 meeting and has reported its findings to the Commission. The ACRS report dated March 11, 1976 is attached as Appendix B. Specific items that were identified in the ACRS report are addressed in the following subsections of this supplement.

11.1 Surveillance of Encapsulated Cables

The ACRS expressed a concern that the gross application of the fire retardant coating, Flamemastic 71A, might involve long-term effects that warrant surveillance. The cocooning of the electrical and control cables with Flamemastic 71A changes the working environment, and an arrangement for opening some portion of the cable bundles to inspect their condition periodically would seem appropriate.

We requested TVA to propose a surveillance program for periodic inspection of the coated cables.

In Revision 42 to the Plan, TVA proposed that "In response to an ACRS concern that the Flamemastic cocooning of electrical cables changes the working environment, approximately every three years during the nearest refueling outage, a nondivisional low-voltage power cable tray on Unit 1 (floor elevation 593) shall have a portion of the Flamemastic cocoon opened, the cables inspected, and a sample of the cable jacketing removed. The jacket sample shall be given an ASTM D412 physical and dimensional test for elongation and tensile strength. The test values shall be compared to previously obtained values to determine the aging of the cable materials.

Repairs to the cable jacket shall be made with a cable jacket repair kit, and the open area shall be recoated with Flamemastic."

TVA maintains that the jacket sample is a more sensitive indicator of insulation aging because the PVC jacketing material has a rating of $75^{o}C$ and the conductor insulating material (cross linked polyethelene) has a $90^{o}C$ rating.

In order to demonstrate that the jacket sample will be valid, TVA tested a typical power cable of similar materials at 335 amperes and measured a $12^{o}F$ ($6.67^{o}C$) temperature difference from the conductor to the inside of the jacket. This test current represents the heaviest type duty that would be experienced by a continuously energized nondivisional power circuit. This test compares favorably with a calculated average value of $3.47^{o}C$ which TVA expects to experience with the divisional control and power cables which will only see periodic operation under normal circumstances.

After discussions with the staff, TVA has agreed to an accelerated surveillance schedule in which the first sample will be made at the first refueling of Unit 1 (6 months-12 months) and the second sample taken at the next refueling outage (about 18 months-24 months).

As a result of our review, we have concluded that there should not be any perceptible increase in the aging rate of the insulation material covered by Flamemastic 71A. We have also concluded that, even if there is a perceptible increase, the proposed test has a sufficient sensitivity to detect accelerated thermal aging, that a jacket sample is a valid indicator of insulation damage, and that the test frequency is sufficiently high to provide timely warning of any deterioration prior to causing a safety hazard. Therefore, we find that the resolution proposed by TVA is acceptable.

11.2 Chemical Behavior of Fire Retardant Coating in a Fire

The ACRS expressed a concern that more information about the chemical behavior of the fire retardant coating, Flamemastic 71A, in the presence of a fire would be desirable. As a result of this concern we requested the supplier of the coating, Flamemaster Corporation, to provide us with a more detailed breakdown of the products of combustion of Flamemastic 71A. In response to our request the supplier provided the results of a test performed by Analytical Research Laboratories, Inc., which were summarized as follows:

> "Combustion tests indicate that Flamemastic 71A does not propagate flame but burns only with difficulty and is self extinguishing upon removal of the heat source. The pyrolosis-combustion process evolves a white smoke and leaves a dense char that makes complete combustion difficult. Chemical analysis of the products of combustion indicates carbon dioxide, water, antimony chlorides, some hydrogen chloride and traces of various chlorinated and other organic compounds."

A description and the results of this test are set forth in Appendix C of this report. Based on the test results and the already known products of combustion of the coating material we find no compound that would be a significant detriment to safety related equipment. The hydrogen chloride and its resultant hydrochloric acid formation was taken into account in our original evaluation of the use of the coating. The amount of chloride contamination from this source is greatly reduced compared to the chlorides that would be produced by the burning of the cable insulation if it were not protected with Flamemastic 71A, such as occurred during the March 22, 1976 fire.

Therefore, based on this test and information already available in the literature, we conclude that the products of combustion of the coating do not preclude the use of the coating as it is being applied to Browns Ferry Plant. In fact, the use of the coating as applied will greatly reduce any potential fire from producing large quantities of combustion products from the electrical cabling it is protecting.

11.3 Use of an Outside Fire Protection Review Agency

The ACRS expressed a concern that, "Since the TVA is self-insured in accordance with federal policy, its installations do not have the normal fire insurance surveillance used by private installations. The TVA...should be supplemented by an outside review agency to assure a broad and unconstrained evaluation of fire protection requirements."

In response to this concern, TVA has committed, in Revision 42, Part XII of the Plan, to procure the services of a qualified fire protection engineering consultant or firm to conduct audits at the plant at three year intervals. We have incorporated the audit as a limiting condition of operation requirement in the Technical Specifications and established the date for the first audit to be during the period of June-September 1977. This audit in conjunction with the annual audit, also required by the Technical Specifications, will adequately cover the concern expressed by the ACRS.

11.6 Fire Protection Procedures and Training

The ACRS letter stated that verification of the adequacy of the fire protection training programs proposed by TVA should be part of the NRC regulatory plan and that the training program should include both initial training and periodic retraining of personnel. The Office of Inspection and Enforcement (OI&E) inspects the procedures and training course content of the licensee to ensure their adequacy. A fire protection consultant was engaged by NRC to provide guidance and criteria for OI&E personnel to perform this function.

He is completing his review and recommendation with respect to these subjects. These are expected shortly and will be covered by a further safety evaluation covering the adequacy of training and procedures for return to operation of the Browns Ferry facility that will be verified by OI&E. Such safety evaluation will form the basis for our final position with respect to these subjects.

11.7 Special Review Group Recommendations

The ACRS wished to be kept informed of the specific application of the Special Review Group's recommendations as they apply to Browns Ferry. Appendix D presents a tabulation of the comparison of Browns Ferry with the Special Review Group's recommendations.

12. Consultants' Reports

In Attachment 2 to the SER, it was stated that summary reports of the TVA and NRC consultants would be placed in the Docket File and Public Document Rooms prior to NRC authorizing return to operation. The NRC consultant did submit a summary report. His report's conclusion, however, was conditioned upon the satisfactory completion of the TVA consultants' evaluation and report. We have not yet received a summary report by the TVA consultants; however, it is presently scheduled for submittal on June 18, 1976. NRC and its consultant will determine that there are no unresolved items or that any that may exist are resolved prior to authorizing return to operation. We will issue a final report on this subject very shortly.

13. Environmental

We have determined that the proposed amendments do not authorize a change in effluent types or total amounts nor an increase in power level and will not result in any significant environmental impact. Having made this determination, we have further concluded that the proposed amendment involve an action which is insignificant from the standpoint of environmental impact and pursuant to 10 CFR 51.5(d)(4), that an environmental statement, negative declaration, or environmental impact appraisal need not be prepared in connection with the issuance of the proposed amendments.

16. Conclusions

Based on our analysis of the restoration and modifications of the Browns Ferry Nuclear Power Plant Units 1 and 2, we have determined that upon favorable resolution of the outstanding matters set forth in Sections 11.6 and 12.0, we will be able to conclude that:

(1) the application for amendment filed by Tennessee Valley Authority dated August 13, 1975, complies with the requirements of the Atomic Energy Act of 1954, as amended (Act), and the Commission's regulations set forth in 10 CFR Chapter 1;

(2) Restoration and construction of the Browns Ferry Nuclear Plant Unit 2 has been substantially completed and of Unit 1 will be substantially completed in conformity with "Plan for Evaluation, Repair and Return to Service of Browns Ferry Units 1 and 2 (March 22, 1975 Fire)" dated April 13, 1975, as revised, the provisions of the Act, and the rules and regulations of the Commission;

(3) The facility will operate in conformity with the application as amended, the provisions of the Act, and the rules and regulations of the Commission;

(4) There is reasonable assurance (i) that the activities authorized by the license amendments can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the regulations of the Commission set forth in 10 CFR Chapter 1;

(5) The applicant is technically and financially qualified to engage in the activities authorized by the license amendments, in accordance with the regulations of the Commission set forth in 10 CFR Chapter 1; and

(6) The issuance of the license amendments will not be inimical to the common defense and security or to the health and safety of the public.

APPENDIX A

February 19, 1976	TVA letter transmitting Consultants' responses to TVA
February 25, 1976	Letter to TVA transmitting Safety Evaluation dated February 23, 1976, regarding our evaluation of the restoration and modifications at the Browns Ferry Nuclear Plant, Units 1 and 2
February 27, 1976	TVA letter transmitting Revision 38 to "Plan for Evaluation, Repair, and Return to Service..."
March 2, 1976	TVA letter transmitting Standard Practice dated 1/21/76 for training Requirements for Operations Employees
March 10, 1976	Letter to TVA transmitting Summary Report received from NRC's Fire Protection Consultant, Mr. Andrew J. Prior, USERDA, Alburquerque Operations Office
March 17, 1976	TVA letter transmitting Revision 39 to "Plan for Evaluation, Repair, and Return to Service..."
April 6, 1976	TVA letter transmitting Revision 40 to "Plan for Evaluation, Repair, and Return to Service..."
April 9, 1976	TVA letter transmitting requested amendment to licenses re removal of fuel pool gates
April 16, 1976	Letter to TVA transmitting Amendment No. 21 to DPR-33 and Amendment No. 18 to DPR-52 re removal of the canal gate and three canal blocks in order to allow safe transfer of the neutron sources from the reactor vessel to the fuel storage pool
April 19, 1976	TVA letter transmitting Revision 41 to "Plan for Evaluation, Repair, and Return to Service..."
April 23, 1976	TVA letter documenting verbal commitments re completion of certain items before startup of either of the fire-affected units
April 30, 1976	TVA letter regarding fuel loading for Units 1 and 2 Unit 1 - 6/11/76, Unit 2 - 5/30/76
May 10, 1976	TVA letter transmitting Revision 42 to "Plan for Evaluation, Repair, and Return to Service..."
May 11, 1976	TVA letter requesting Amendment relating to MCPR and MAPLHGR limits, LPCI modification, and supplement to proposed fire protection Technical Specifications

May 21, 1976	TVA letter transmitting a report entitled "Browns Ferry Nuclear Plant Units 1-3, RHR Pump Protection Against Operation in Excess of Design Runout"
May 28, 1976	TVA letter requesting Amendment to load fuel in Units 1 and 2
June 10, 1976	TVA letter regarding the addition of a Safety Engineer to the Browns Ferry Nuclear Plant staff
June 10, 1976	TVA letter transmitting Revision 43 to "Plan for Evaluation, Repair, and Return to Service..."
June 15, 1976	TVA letter transmitting Revision 44 to "Plan for Evaluation, Repair, and Return to Service..."
June 16, 1976	TVA letter transmitting Revision 45 to "Plan for Evaluation, Repair, and Return to Service..."
June 16, 1976	TVA letter transmitting infinite multiplication factor for Unit 2 fuel
June 17, 1976	TVA letter transmitting Quality Assurance for fire protection systems

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

March 11, 1976

Honorable William A. Anders
Chairman
U. S. Nuclear Regulatory Commission
Washington, DC 20555

Subject: REPORT ON PROPOSED RESTORATION AND OPERATIONAL TESTING OF BROWNS FERRY NUCLEAR PLANT, UNITS 1 AND 2

Dear Mr. Anders:

At its 191st meeting, March 4-6, 1976, the Advisory Committee on Reactor Safeguards met with the Tennessee Valley Authority (TVA) to review repairs and modifications to be made to the Browns Ferry Nuclear Plant, Units 1 and 2 prior to restart of these units following the fire on March 22, 1975. These matters were previously considered at a Subcommittee meeting on February 27, 1976, in Washington, DC. During its review, the Committee had the benefit of discussions with representatives and consultants of the Tennessee Valley Authority and the Nuclear Regulatory Commission (NRC) Staff. The Committee also had the benefit of the documents listed.

The Browns Ferry Nuclear Plant consists of three boiling water reactors. At the time of the fire Units 1 and 2 were operating and Unit 3 was still under construction. Following the fire the fuel was removed from Units 1 and 2 and since has remained stored in the fuel storage pools. The Technical Specifications were changed to provide for protective measures for the fuel while in the storage pools.

TVA has conducted an extensive program to determine damage from the fire. It was concluded that the major damage occurred in the reactor building, outside the cable spreading room where the fire started. There has been no evidence of significant structural damage and only minor damage to piping systems. There was extensive damage to electrical cables, trays and conduits. There was extensive deposition of soot on all equipment located in the reactor building below the refueling floor. This soot contained an estimated 1400 pounds of chloride. All damage occurred in the reactor building outside the containment.

Based on its assessment of the damage from the fire, TVA has developed and carried out a program for restoration of Units 1 and 2. This has consisted of replacing, from terminal to terminal, all damaged cables in the reactor protection system, primary containment isolation system and engineered safeguards systems. Some other cables that were damaged have been repaired by splicing.

Because of the extensive nature of these repairs it is extremely important that preoperational tests ascertain that repairs have been adequate to restore required functions. Test procedures are being prepared by TVA and are being reviewed by the NRC Staff. The ACRS wishes to be informed of the results of these tests prior to startup of Units 1 and 2. A cleaning program has been carried out to remove the soot, and tests have been conducted to determine damage from the soot. While the cleaning program seems adequate, effects of the chlorides, such as stress corrosion cracking, may not be evident for some time. TVA has proposed a surveillance program to detect future deterioration that might be caused by these chlorides. The NRC Staff is reviewing the program to determine its adequacy. The ACRS emphasizes the importance of such a program and wishes to be kept informed of the results.

Of the 9500 electrical conductors involved, 45% have been replaced entirely and criteria for splicing the remainder have been developed and followed. Additional heat and smoke detectors have been installed. A fire retardant coating, Flamemastic 71A, has been used to reduce flammability. Fire watches have been established. Automatic fire protection systems and hand-held fire suppression systems will be installed to promptly suppress fires that may occur. Water spray will be used at critical locations. Changes in communications are planned. The Committee believes that these represent significant improvements in fire protection.

Some of the fire control provisions and in particular the gross application of Flamemastic 71A might involve long-term effects that warrant surveillance. The cocooning of the electrical and control cables with Flamemastic 71A changes the working environment, and an arrangement for opening some portion of the cable bundles to inspect their condition periodically would seem to be appropriate.

The fire retardant action of the Flamemastic 71A has not been clearly described and, while tests indicate that it is effective, more information about its chemical behavior in the presence of a fire would be desirable. If the supplier of the material cannot provide the chemical information, the NRC Staff should request an independent laboratory to investigate its behavior as a precautionary measure to determine the toxicity and corrosive properties of the chemicals evolved during a fire.

The criteria for access for fire fighting purposes, while difficult to define, should be set forth by the NRC Staff for Applicants, so that there is a basis for judging the adequacy of the provisions. The situation at Browns Ferry is governed largely by the already constructed installation, but there may be opportunities for improving or modifying what is proposed.

Since the TVA is self-insured in accordance with federal policy, its installations do not have the normal fire insurance surveillance used by private installations. The TVA has established an independent fire protection staff within its organization. However, a newly established unit may not have either adequate status or experience to be wholly effective and should be supplemented by an outside review agency to assure a broad and unconstrained evaluation of fire protection requirements.

Verification of the adequacy of the fire protection training programs proposed by TVA should be part of the NRC regulatory plan. The training program should include both initial training and periodic retraining of personnel.

Following the Browns Ferry fire the NRC Executive Director for Operations set up a special review group to determine what should be learned from this incident. This group has made recommendations that apply to future reactors, to reactors that are already operating, and to the NRC regulatory process. The review group points out that its recommendations are not specific to any single plant and that its recommendations are based on knowledge at the time of this investigation. The ACRS wishes to be kept informed of the specific application of the review group's recommendations as they apply to Browns Ferry, to the development of additional information on fire prevention, fire fighting and quality assurance and the improvement of NRC policies, procedures and criteria.

The Committee expects to review generically several safety questions related to boiling water reactors, including Mark 1 torus response, during the next several months. These questions as they may relate to Browns Ferry will be addressed in the Committee's generic reports on these subjects.

The Advisory Committee on Reactor Safeguards believes that, if due regard is given to the items mentioned above, and subject to satisfactory completion of the planned restoration and subsequent operational testing, there is reasonable assurance that the Browns Ferry Nuclear Plant, Units 1 and 2, can be operated at power levels up to 3293 MWt, subject to the conditions of the Committee's reports of September 21, 1972, and December 11, 1973, without undue risk to the health and safety of the public.

Sincerely yours,

Dade W. Moeller

Dade W. Moeller
Chairman

References

1. "Plan for Evaluation, Repair, and Return to Service of Browns Ferry Nuclear Plant, Units 1 and 2 as a Result of the March 22, 1975, Fire" by the Tennessee Valley Authority and Revisions 1 through 37 to that plan.

2. "Recommendations Related to Browns Ferry Fire" (NUREG-0050) Report by Special Review Group dated February 1976.

3. Safety Evaluation by the Division of Operating Reactors Supporting the Operation After the Restoration and Modification of the Browns Ferry Nuclear Plant, Units 1 and 2 following the March 22, 1975, Fire dated February 23, 1976.

4. NRC letter to Tennessee Valley Authority dated May 9, 1975, issuing temporary Tech Specs for use during recovery from fire damage.

5. Tennessee Valley Authority letter dated June 11, 1975, regarding QA provisions during cable splicing operations.

6. NRC letter to Tennessee Valley Authority dated June 13, 1975, modifying the Tech Specs for the period when Units 1 and 2 were defueled and the fuel stored in the fuel pools.

7. Tennessee Valley Authority letter dated August 18, 1975, forwarding responses to NRC questions relating to the Browns Ferry fire.

8. Tennessee Valley Authority letter dated August 21, 1975, commenting on the capability of obtaining total independence of redundant systems.

9. Tennessee Valley Authority letter dated August 29, 1975, committing itself to certain actions.

10. Tennessee Valley Authority letter dated September 15, 1975, formally committing TVA to actions regarding fire protection systems.

11. Tennessee Valley Authority letter dated November 17, 1975, regarding procedures for full-scale flame tests of wall penetration seal designs.

12. Tennessee Valley Authority letter dated December 8, 1975, regarding heat shield barrier design.

13. NRC letter to Tennessee Valley Authority dated December 19, 1975, modifying the Tech Specs to reflect reduced cooling requirements for the fuel stored in the fuel pools.

References - Continued

14. Tennessee Valley Authority letter dated January 15, 1976, transmitting data from fire tests performed on candidate electrical cable wall penetration seal/fire stop designs.

15. Tennessee Valley Authority letter (undated) to B. C. Rusche transmitting Enclosures 1, 2 and 3 re: Recommendations of fire consultants and TVA responses; and additional information on the "Plan for Evaluation, Repair, and Return to Service of Browns Ferry Nuclear Plant, Unit 1 and 2.

16. Tennessee Valley Authority consultant's (Associated Fire Protection Consultants, Inc.) letter reports dated February 25 and March 4, 1976.

17. NRC letter to ACRS dated March 4, 1976, forwarding the Summary Report of the NRC's Fire Protection Consultant.

ANALYTICAL RESEARCH LABORATORIES, INC.

160 TAYLOR STREET, P.O. BOX 369, MONROVIA, CALIFORNIA 91016 (213) 357-3247

Lab/Shipper Log Number 36075

APPENDIX C -1

Material/Sample Identity			Date Received
Flamemaster/Flamemastic 71A Batch 030086			3/23/76
P.O. or R.P. Number	Requested By		
5783	Dr. Roger Peterson		
Work Order	Sample Disposition ☐ Retain ☐ Return ☒ Destroy	Nature of Hazard	Due Date
6951-01			

Ship To:

Flamemaster Corp.
11120 Sherman Way
Sun Valley, Ca. 91352

Nature of Work and Information Desired

Determine nature of gaseous combustion products.

Summary of Laboratory Report

Q.C. Level

Combustion tests indicate that Flamemastic 71A does not propagate flame but burns only with difficulty and is self extinguishing upon removal of the heat source. The pyrolysis-combustion process evolves a white smoke and leaves a dense char that makes complete combustion difficult. Chemical analyses of the combustion products indicates carbon dioxide, water, antimony chlorides, some hydrogen chloride, and traces of various chlorinated and other organic compounds.

A discussion of the analytical methods is attached. Most of the work was qualitative or semi-quantitative in nature due to time constraints.

Analyst	Date	Approved By	Book-Page
NH	4/1/76		

Research and Development Testing

ANALYTICAL RESEARCH LABORATORIES, INC.

160 TAYLOR STREET, P.O. BOX 369, MONROVIA, CALIFORNIA 91016 (213) 357-3247

Lab Log 36075, WO 6951-01

Scope

The following studies are of a general survey nature to develop the maximum useful information concerning pyrolysis-combustion characteristics of Flamemastic-71A in a short time.

Test Methods

A sample of Flamemastic 71A was suspended on a wire and heated with a gas burner until a dense white smoke was evolved. The flame was then removed and the specimen was quickly covered with a glass bell jar to trap the products of combustion and pyrolysis. The experiment was thus designed to yield incomplete combustion in order to simulate conditions that might be expected in an actual plant fire.

The gases trapped under the bell jar were sampled and analyzed by mass spectrometry. Qualitative chemical tests and emission spectrometry were used to determine the nature of the solid and liquid components.

Results

Burning Observations - The specimen of Flamemastic 71A did not support flame propagation. Holding it in a gas burner flame produced a heavy white smoke and only a small flame that was immediately extinguished upon removal of the burner flame. The material subjected to the burner flame left a dense residual char indicating incomplete combustion.

Analysis of Gaseous Combustion Products - Mass spectrometric analysis of the atmosphere and combustion gases trapped in the bell jar gave the following:

	Vol.-%
N_2	77.3
O_2	19.9
A	0.91
CO_2	1.83

The above data indicate only slight combustion of the sample after removal of the burner as much excess air is still present. It is conceded that some

carbon monoxide also may be present but not detected by mass spectrometry in the presence of much nitrogen. In order to obtain an analysis of the minor amounts of organic species, a sample was concentrated by liquid nitrogen trapping to give the following:

	ppm
Dichloroethane	500.
Alcohol (probably CH_3OH)	600.
Acetone	10.
Benzene	5.
Toluene	30.
Ethyl chloride	100.
Carbon tetrachloride	30.
Vinyl acetate*	1,000.

*Tentative identification-the mass spectrum is consistent with the presence of vinyl acetate monomer, but further work is needed for unequivocal identification.

The above data indicate only the ratios and types of compounds produced under the laboratory burning/pyrolysis conditions. Concentrations and even species will vary widely with the degree of air dilution and actual fire conditions.

Water and some hydrogen chloride are expected in the burning of Flamemastic 71A, but these species were not detected by mass spectrometry due to predictable surface adsorption retention.

Analysis of Condensible Products - The firing of a sample of Flamemastic 71A gave a white smoke with minute aqueous droplets that were condensed on a cold glass surface in a separate qualitative test. The condensate gave a slight but definite test for strong acid but a much higher chloride level. Emission spectrographic analysis of the white deposit confirms antimony as the major element with a minor of iron, and a trace of silicon. Qualitative tests also indicated the presence of traces of phosphates, as would be expected.

From the known formulation of the material, the above is readily explained. Burning of the chlorinated hydrocarbons is known to produce hydrogen chloride and some does enter the atmosphere where it is quickly condensed as a hydrochloric acid mist in the presence of the water from both the combustion and normal atmosphere. Much of the hydrogen chloride, however, reacts with the antimony oxide under the fire conditions to produce, presumably, antimony trichloride.* The

*The level of HCl evolution is further reduced by the presence of calcium carbonate in the formulation.

insitu production of this material and its reaction with the concurrently evolved moisture probably accounts for the white smoke. This heavy fume acts to retard combustion. While the quantitative composition of the smoke, or white deposit, was not determined, it probably consists mainly of a finely dispersed mixture of antimony chlorides, and oxychlorides, with some entrained oxide and aqueous hydrogen chloride mist.

APPENDIX D

COMPARISON OF BROWNS FERRY PLANT, AS MODIFIED, WITH

"RECOMMENDATIONS RELATED TO BROWNS FERRY FIRE REPORT

BY SPECIAL REVIEW GROUP" (NUREG-0050)

NUREG-0050
Section & Page

Section 3.2 Criteria for Fire Prevention and Control

1. Page 15 RECOMMENDATION

More comprehensive regulatory guidance is needed - develop standards for acceptable fire protection design methodology.

RESPONSE

This recommendation concerns future guidance or requirements to be developed by NRC. When the guidance is forthcoming in the form of Regulatory Guides or when Standards or Regulations are issued on this topic, the area will be re-evaluated for the Browns Ferry Plant to the same extent required for other licensed plants.

Section 3.3.1 Fire Prevention in Design

2. Page 16 RECOMMENDATION

Include measures to avoid potential problems with areas containing a high density of combustible material - provide system for maintaining an inventory of combustible material. Assess combustible material in each safety-related area and take appropriate combination of measures for protection.

RESPONSE

TVA has assessed the installed combustible materials at the Browns Ferry Plant (Section 4.0 of SER) and provided measures including fire detection (Section 7.5.2 and 7.5.3), coating all exposed cable surfaces with a fire retardant material (Section 7.2), installing fixed water spray or sprinkler systems (Section 7.5.1), adding fire hose stations to enhance coverage of accessible areas with combustible materials (Section 5.0), improved training, procedures, and organization for fire protection activities (Section 6.1, 6.2 and 6.3), and an improved overall Quality Assurance Program (Section 6.4) to provide the proper amount of control of combustibles and extinguishment capability for the associated loading of installed combustibles.

For combustibles that are temporarily brought into areas of the plant, administrative controls have been established to increase the fire protection appropriately (Section 6.3).

3. Page 16 RECOMMENDATION

Alternative for future plants is establishment of fire zones arranged for adequate isolation of redundant safety equipment.

RESPONSE

This recommendation applies to future plants.

Section 3.3.2 Operating Considerations in Fire Prevention

4. Page 16 RECOMMENDATION

Measures available for fire protection should be embodied in written procedures.

RESPONSE

TVA has provided additional written procedures for fire protection (Section 6.2). This recommendation has been incorporated in the Technical Specifications as a requirement.

5. Page 16 RECOMMENDATION

Develop regulatory guides - allot review and inspection resources.

RESPONSE

This recommendation applies to the review of future plants and the re-review of the other operating plants and those for which licenses have already been requested.

Section 3.4 Criteria for Combustibility of Materials

6. Page 17 RECOMMENDATION

More development work on materials and testing methods and development of selection criteria - decrease combustibility of present materials needing protection.

RESPONSE

The basic objective of this recommendation is to decrease combustibility. TVA has decreased the combustibility of present materials needing protection by the application of fire retardant coating to all exposed cable surfaces in all areas containing equipment required for safe shutdown (Section 7.2).

Section 3.4.1 Cable Insulation Criteria

7. Page 18 RECOMMENDATION

Follow Sandia and NELPIA-UL programs - Following completion of the programs implement changes in existing plants where significant safety improvement is indicated.

RESPONSE

We intend to follow this recommendation..

8. Page 18 RECOMMENDATION

Include study of airborne products of heating and combustion in flammability investigations.

RESPONSE

This is a cable selection recommendation aimed at reducing the atmospheric release of such products. TVA has used a flame retardant coating to accomplish this purpose.

9. Page 19 RECOMMENDATION

Judicious use of fire retardant coatings - research and testing on coatings.

RESPONSE

TVA has provided an acceptable fire retardant coating for all exposed cable surfaces in all areas containing equipment required for safe shutdown (Section 7.2).

Section 3.4.2 Criteria for Fire Stops and Seals

10. Page 21 RECOMMENDATION

Develop qualification tests for individual materials as well as assembled fire stop - testing to be performed by qualified independent testing laboratory.

RESPONSE

We did not require testing by a qualified independent laboratory. TVA conducted their own series of tests to develop a fire stop for Browns Ferry at the Watts Bar Test Facility. NRC reviewed and approved these results (Section 7.4).

11. Page 21 RECOMMENDATION

Consider the possibility of providing fire stops at specified intervals in long cable trays.

RESPONSE

All exposed cable insulation surfaces in safety related areas have been coated with Flamemastic 71A providing essentially a continuous fire stop.

12. Page 21 RECOMMENDATION

Consider on a case-by-case basis removal of unapproved foam plastic seals.

RESPONSE

TVA has removed all polyurethane seal material to the extent practical. Where polyurethane material is left it has been covered by at least six inches of the new seal material plus redundant barriers of insulation material (Section 7.4).

13. Page 21 RECOMMENDATION

Replace or demonstrate acceptability of extremely flammable material in fire stops such as the flexible polyurethane foam used as dams and plugs at Browns Ferry.

RESPONSE

All flexible polyurethane foam has been removed at Browns Ferry (Section 7.4).

14. Page 21 RECOMMENDATION

Seal all openings in control room in order to protect habitability.

RESPONSE

TVA has sealed all openings in the control room and the ventilation system is designed to provide isolation for habitability (Section 7.4 and 7.5.7).

15. Page 21 RECOMMENDATION

Consideration should be given to the addition of stops and seals in existing plants to reduce spread of fire, smoke, and gases.

RESPONSE

The Reactor Building is a complex structure with requirements for established ventilation patterns to achieve proper distribution and control of potential radioactivity. There is no practical way to accomplish this recommendation for isolation of floors, etc. The intent of the recommendation, however, i.e., to minimize the spread of the products of combustion, has been achieved by minimizing the contained combustible material including Flamemastic coating of exposed cables. In addition, improvements have been made in fire related administrative procedures and automatic detection and extinguishment systems have been added.

Section 3.5.1 Fire Detection and Alarms Systems

16. Page 22 RECOMMENDATION

Assure compatability of smoke detectors with anticipated products of combustion.

RESPONSE

TVA is providing detectors that are UL approved for the application with the materials installed in the plant. Design review and field surveys will have been made to assure proper location of detectors taking into account obstructions and air pockets. (Section 7.5.3)

17. Page 22 RECOMMENDATION

Provide better guidance on fire detectors, preferably based on experiments with existing cables and detectors.

RESPONSE

This recommendation applies to future plants. See response to Recommendation 18 below.

18. Page 22 RECOMMENDATION

Review and upgrade, as necessary, installed fire detection systems in all plants.

RESPONSE

TVA has upgraded the fire detection systems in Browns Ferry (Sections 7.5.2 and 7.5.3).

Section 3.5.2 Design of Fire Extinguishing Systems

19. Page 24 RECOMMENDATION

Emphasize need for quickly putting out all fires - factor into fire procedures and fire training.

RESPONSE

TVA has added fixed water spray and sprinkler systems for the purpose of providing a rapid means of distributing the extinguishing agent (Water) to a cable fire. (Section 7.5.1) In addition, more fire hose racks have been installed and the training program and procedures, including prefire plans, now reflect an emphasis on the ability of water to extinguish cable fires. (Section 6.1 and 6.2).

20. Pages 24 & 25 RECOMMENDATION

Recommend fixed extinguishing systems, automatic if feasible, in areas with high density of flammable material especially where access is difficult.

RESPONSE

TVA is providing such systems for Browns Ferry. (Sections 7.5.1, 7.6.1, 7.6.2 and 7.6.3).

21. Page 24 RECOMMENDATION

Consider drainage needs and potential for water damage in design of water extinguishment systems.

RESPONSE

TVA has taken into account the drainage and sump capacity requirements associated with the spray and sprinkler systems. (Sections 7.5.1, 7.6.1, and 7.6.3). Protection of all safety related equipment from the effects of water drainage from operation of these systems was also taken into account by providing shields and covers where required. (Sections 7.5.1 and 7.6).

22. Page 24 RECOMMENDATION

Develop guidance for specification of quality and design requirements for water sprinkler systems.

RESPONSE

Development of such guidance is underway. The adequacy of the Browns Ferry sprinkler system was reviewed and, as modified, are considered acceptable.

23. Page 25 RECOMMENDATION

In design of future plants, continue to provide high pressure water system (hoses, nozzles, hydrants) in all plant areas including those protected by sprinklers or sprays.

RESPONSE

At Browns Ferry, all areas, even those with sprays and sprinklers, will have water coverage available from at least two hose stations.

Section 3.5.3 Ventilation Systems and Smoke Control

Page 25 RECOMMENDATION

Review and upgrade ventilation systems to (a) assure continued functioning if needed during a fire and (b) provide capability of isolating fires by cutout valves or dampers - these provisions to be compatible with requirements for containment of radioactivity.

RESPONSE

The cable spreading rooms' ventilation systems have been modified and meet this recommendation (Section 7.3). The measures taken to protect against the two divisions of cabling from being affected by a fire (Section 7.0) ensure the availability of at least one Standby Gas Treatment System Train which could be utilized for ventilation in the Reactor Building.

The remainder of the areas required for safe shutdown of the plant have been evaluated and their emergency features for secondary containment isolation or for isolation to maintain habitability in the event of radioactive releases or smoke or toxic gas releases outside the area being protected, must retain priority over the capability to exhaust smoke (Section 7.5.7). However, maintenance of ventilation systems operability has been enhanced by the protection afforded from the fire-retardant coating of all exposed cable surfaces and other measures taken to reduce the effects of a fire.

Section 3.5.4 Fire Fighting

25. Page 25

RECOMMENDATION

Include, in emergency plans, access and escape routes to cover event of a fire in critical plant area - Consider this aspect in design of future plants.

RESPONSE

TVA is providing prefire plans which include among other things the access and egress routes from areas of the plant where fires are likely to occur or where equipment related to safe shutdown of the plant is located. (Section 6.2).

26. Page 26

RECOMMENDATION

Assure compatibility of fire fighting equipment with off site units.

RESPONSE

TVA has now installed equipment that is compatible with the Athens, Alabama Fire Department equipment.

27. Page 26 RECOMMENDATION

Review and upgrade, as necessary, available breathing equipment and means of recharging - consider this aspect in future designs.

RESPONSE

TVA has added requirement to the training program to ensure that the personnel know how to properly use breathing apparatus (Section 6.1). TVA has also upgraded plant breathing apparatus charging capability from bottles and added a compressor charging system (Section 7.5.4).

Section 3.5.5 Prevention and Readiness Efforts During Construction and Operation

28. Page 26 RECOMMENDATION

Develop plan for periodic testing of fire protection systems including individuals and their responsibilities.

RESPONSE

TVA has incorporated a testing program and schedule (Sections 6.2 and 6.3). TVA also has provided a new position on the operating staff, one of encumbent's responsibilities is to ensure that the fire protection equipment is tested and maintained (Section 6.3).

29. Page 26 RECOMMENDATION

Include requirements for operability and surveillance testing of fire protection systems in Technical Specifications.

RESPONSE

The Technical Specifications for Browns Ferry will include operability and surveillance requirements for the fire protection systems (Section 8.0).

30. Page 27 RECOMMENDATION

Provide temporary measures when fire protection equipment is disabled for maintenance or when fire stops are breached.

RESPONSE

TVA has instituted administrative controls for providing supplemental fire ptorection measures when an installed fire protection or detection system is disabled for maintenance or when a fire stop is breached (Section 6.2).

31. Page 27 RECOMMENDATION

Emergency plans should recognize need for fire fighting concurrent with other activities.

RESPONSE

In regard to plans for fire fighting concurrent with other activities, TVA has reorganized the Fire Brigade (Section 6.3) to designate a specific portion of the operating shift crew as Brigade members leaving the remaining portion of the operating shift for other activities associated with safe operation or shutdown of the plant.

32. Page 27 RECOMMENDATION

Conduct periodic fire drills to include onsite and offsite personnel and organizations that would normally respond to fires.

RESPONSE

The Browns Ferry Plant onsite fire fighting equipment and personnel (plant fire brigade) are intended to be, and were found to be by our review, adequate without assistance from the offsite Athens Fire Department. The offsite fire department is intended only as backup to onsite capability. Agreements, plans and orientation visits to the Browns Ferry plant have been arranged with the Athens Fire Department; however, we do not require their participation in fire drills. Periodic drills are held with the offsite TVA emergency organization and communications drills are made with non-TVA organizations.

Section 4.1.2 Role of Normal Cooling Systems

33. Page 31 RECOMMENDATION

Consider independence of normal and safety systems which could cool the reactor.

RESPONSE

Although this has never been an NRC review requirement, the Browns Ferry design demonstrated sufficient independence of normal systems to provide core cooling during and after the March 22, 1975 fire. Our primary objective in the fire protection review was to assure that TVA had provided sufficient redundancy, diversity, and isolation within the divisional safety systems without reliance on other systems to assure reactor cooling in the event of a fire.

Section 4.2 Redundancy and Separation - General Considerations

34. Page 32 RECOMMENDATION

Consider manual valve manipulation capability in design of all plants.

RESPONSE

This capability was considered and included in the original Browns Ferry design.

Section 4.3.2 Common Mode Failures Attributable to Indicator Light Connections

35. Page 36 RECOMMENDATION

Recommends assurance of adequacy of isolation between safety equipment and non-safety circuits.

RESPONSE

The indicating lamp circuits which led to the loss of redundant Motor Operator Valve (MOV) boards have been removed at Browns Ferry (Section 7.1).

Section 4.3.3.1 Trays and Conduit

36. Page 36 RECOMMENDATION

Need improved criteria regarding use of conduit.

RESPONSE

Section 7.1 discusses the combined modifications at Browns Ferry to provide adequate conduit protection. They include some relocation, coating of exposed cable surfaces and addition of fixed water systems to wet the conduit.

Section 4.3.3.3 Cable Spreading Room (CSR)

37. Page 37 RECOMMENDATION

Need improvement in criteria for cable spreading room including separation and access for fire fighting.

RESPONSE

SER Attachment 3(A.1, A.2) discusses improvements in the Browns Ferry CSR protection. They include automation of the CO_2 system, coating of all exposed cable surfaces and the addition of a back-up manual sprinkler system.

Section 4.3.4.1 Browns Ferry Criteria for Physical Separation and Isolation of Redundant Circuits

38. Page 40 RECOMMENDATION

Steel cable tray covers appear to be inadequate fire barriers.

RESPONSE

Fire barrier credit is not taken for cable tray covers in the Browns Ferry redesign.

Section 4.3.4.4 Criteria for the Future

39. Page 42 RECOMMENDATION

Improve existing NRC separation and isolation criteria.

RESPONSE

This is a recommendation for the future not applicable here.

40. Page 45 RECOMMENDATION

Practical to provide separate cable spreading rooms for each division in future plants.

RESPONSE

This is a recommendation for the future not applicable to this plant.

41. Page 46 RECOMMENDATION

Separate redundant manual control switches by suitable fire barriers.

RESPONSE

Although this is a recommendation for the future, we noted that the redundant manual control switches at Browns Ferry have canned enclosures and have a minimum separation of 6 inches air space. We have not required additional fire barriers for this plant.

Section 4.4 Instrumentation Required for Operator Action

42. Page 47 RECOMMENDATION

Urges NRC and industry standard groups to develop standards and requirements for instrumentation required for operator information and action.

RESPONSE

This is a recommendation for the future Such standards and requirements when developed will be considered to the extent applicable.

Section 5.2 Lapses in Quality Assurance at Browns Ferry

43. Page 49 RECOMMENDATION

Reevaluate revised Browns Ferry QA program in light of experience of the fire.

RESPONSE

TVA has a new QA program for Operations which meets the current NRC requirements. In addition, OI&E will verify that the appropriate portions of the detailed QA Procedures Manual have been modified to address the area of fire protection.

44. Page 50

RECOMMENDATION

Operating QA programs in older reactors, known not to conform to current standards, should be upgraded promptly.

RESPONSE

The Browns Ferry program has been upgraded.

45. Page 50

RECOMMENDATION

Upgrade the NRC Inspection program.

RESPONSE

The NRC inspection program for the restoration and modification at Browns Ferry has been upgraded to include fire protection systems, fire prevention, and fire fighting.

46. Page 50

RECOMMENDATION

Licensee QA programs, and NRC licensing and inspection programs should include explicit reference to fire prevention, fire fighting and consequence mitigation in their written procedures.

RESPONSE

The NRC licensing and inspection programs for the Browns Ferry restoration and modifications explicitly evaluate fire prevention, fire fighting, and fire prevention and the SER and its supplements and the inspection reports provide written evidence of this.

Section 5.3.1.2 Offsite

47. Page 51

RECOMMENDATION

Consideration should be given to providing alternate or emergency power supplies for fixed in-plant radiological monitoring equipment or providing sufficient manpower for use of portable monitors.

RESPONSE

TVA is preparing emergency procedures to provide added presonnel and portable equipment.

48. Page 51

RECOMMENDATION

"Standby" classification in emergency plans appears necessary to cover those incidents (like the fire) with potential for later triggering one of the four major incident classification categories.

RESPONSE

TVA is changing their Emergency Procedures to provide for a "standby alert" condition.

Section 6.2.3 NRC Organization - Application to Unusual Events and Incidents

49. Page 54,60

RECOMMENDATION

Improve NRC procedures for the safety review of incidents. Clarify the concept of "Lead responsibility".

RESPONSE

OI&E and ONRR are now holding regular monthly meetings to discuss issues as they arise regarding interface relationships between the offices. As an outgrowth of these meetings, new written guidelines are under development defining more clearly the responsibility for these interface areas.

50. Page 55

RECOMMENDATION

Implementation of Review Groups recommendations must be decided plant-by-plant.

RESPONSE

This tabulation together with the SER for the return to operation of Browns Ferry shows the implementation of the SRG recommendations appropriate for this plant at this time. As the staff implements additional SRG recommendations in the future, the need for further action for this plant as well as others, will be considered.

Section 6.3 NRC Action Before the Fire

51. Page 56

RECOMMENDATION

Present NRC programs in fire prevention and control research, standards and criteria, licensing and inspection should be continued and expanded as needed and as recommended in report.

RESPONSE

Additional fire protection requirements generated by such continued and expanded efforts will be considered for this plant to the extent that significant improvements in safety can be achieved.

Section 6.3.3 Inspection of Licensee Operations

52. Page 57

RECOMMENDATION

Reevaluate procedures for resolution by NRC management of issues involving "poor practice" findings by inspectors.

RESPONSE

The staff recognizes the need for NRR to responsibly deal with "feedback" from IE inspectors and where appropriate, will develop enforceable criteria and requirements applicable to this and other nuclear power plants.

Section 6.4 NRC Action During and After the Fire

53. Page 58 RECOMMENDATION

Develop alternate modes of transportation for emergency use to avoid undue delays between a region office and a site.

RESPONSE

Alternative methods of transporatation from house or Regional Office to the affected nuclear site at any hour are being evaluated. The objective is to assure dispatch of appropriate personnel within two hours after notification.

54. Page 58 RECOMMENDATION

Give attention to availability of back-up management and technical personnel at Headquarters to provide for a prolonged emergency.

RESPONSE

Duty Officers are being established in all the offices necessary to respond to any emergency.

55. Page 58 RECOMMENDATION

Provide improved communications facilities - start with a system study.

RESPONSE

An Incident Management Center(IMC) has been established in the IE Headquarters Office in Bethesda, The Center houses the existing communications equipment for incident management, which consists of telephones with arrangements for conference calls. During emergency periods, the NRC operators' services are available for assisting the IMC on an augmented basis. Four of the IE principal staff and the IE Duty Officers have been assigned papers for prompt response to messages. Two facsimile machines and communicating magnetic card typewriters are located within the IE offices. Procedures for notification of their agencies are in effect.

Acquisition of communications facilities and development of procedures necessary to establish a link between Headquarters, Regions and the incident site remains to be accomplished. AT&T consultation for the discussion of operational needs and equipment has been arranged. Internal procedures are under development.

Section 7.0 Response to Other Government Agencies

56. Page 61 RECOMMENDATION

Alabama and local governments should reassess and strengthen emergency notifications methods and procedures.

RESPONSE

Meetings have been held with the Alabama and local officials and training sessions and drills have been held with the appropriate emergency personnel.

Section 7.2.2 Tennessee

57. Page 62 RECOMMENDATION

TVA emergency spokesman needs to use more careful phraseology to avoid inciting undue alarm in offsite agencies.

RESPONSE

This recommendation has been passed on to TVA.

58. Page 63 RECOMMENDATION

Recommend continued efforts for helping States develop radiological emergency response plans.

RESPONSE

Efforts are continuing in this area.

Section 7.3.6 Drills and Exercise

59. Page 64 RECOMMENDATION

Recommends that drills and exercises to test emergency interface between TVA, the State of Alabama and its local governments be conducted at least annually.

RESPONSE

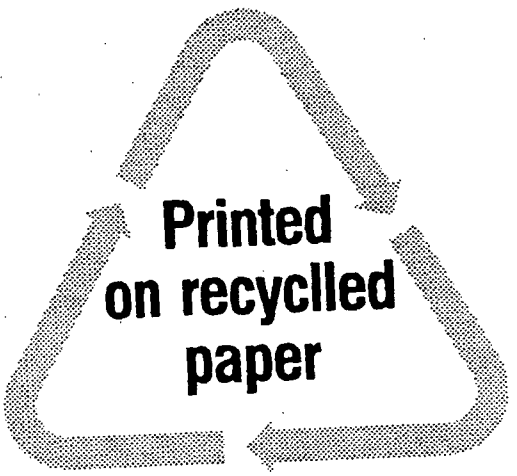
TVA plans to make these periodic drills more effective to ensure full communications coverage.

60. Page 7-11 RECOMMENDATION

Other licensees should also initiate adequate regular excercises to promote maintenance of emergency response capability by local government.

RESPONSE

This recommendation is for other licensees.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