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UNITED STATES
NUCLEAR REGULATORY COMMISSION
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MEMORANDUM FOR: Chairman Ahearne

THRU: William J. Dircks, (Signed) William J. Dircks
Executive Director for Operations

FROM: Harold R. Denton, Director
Office of Nuclear Reactor Regulation

SUBJECT: PLAN FOR INVESTIGATION OF THE INTERACTION BETWEEN ELECTROMAGNETIC PULSE AND COMMERCIAL NUCLEAR PLANT SYSTEMS

The enclosed plan is currently being implemented.

Arrangements for funding an NRC contractor and for transfer of funds to the Defense Nuclear Agency, are being made with the immediate objective of holding the initial plant visit by October 1, 1980.

Negotiations are also underway to establish a Review Panel.

TVA has been very receptive to the plan and has agreed to cooperate.

for Original Signed By)
E. G. Case
Harold R. Denton, Director
Office of Nuclear Reactor Regulation

Enclosure: Study Plan

cc: Commissioner Hendrie
Commissioner Gilinsky
Commissioner Bradford
SECY
OGC
OPE

U. S. NUCLEAR REGULATORY COMMISSION

PLAN FOR INVESTIGATION OF THE

INTERACTION BETWEEN ELECTROMAGNETIC PULSE AND

COMMERCIAL NUCLEAR PLANT SYSTEMS

I. BACKGROUND

Electromagnetic Pulse (EMP) is the term used to describe the intense electromagnetic field generated by a high altitude nuclear weapon explosion. The EMP from a single explosion at sufficient altitude could generate large currents and voltages in electrical equipment over the continental United States.

U. S. Defense Department strategists have been concerned that EMP could be used to temporarily immobilize our land based retaliatory missiles, allowing these missles to be destroyed, while on the ground, by highly localized nuclear strikes. Vital communications networks could also be disabled by EMP as a precursor to an attack. As a result, weapons systems and defense communications systems have been "hardened" against EMP by shielding or by installation of protective devices.

The possibility of nuclear attack against missile sites, preceded by EMP but not including directed attacks on population centers, leads to the concern that commercial nuclear plants may be adversely affected by EMP causing significant health effects, even when compared with those of the nuclear attack.

In addition to EMP generated as a part of a general nuclear attack by a major power there are the possibilities of terrorist explosions of nuclear devices and generation of EMP-like signals using land based generators.

Commercial nuclear plants have not been hardened against EMP. The effects of EMP on a nuclear plant (Sequoyah) have been studied by Oak Ridge National Laboratory, but too many issues were left unresolved by that study to conclusively show that nuclear plants can be safely shut down subsequent to an EMP. Some of the newer operating plants and plants still under construction use electrical equipment such as transistors, integrated circuits and other semi-conductors considered to be particularly vulnerable to high currents and voltages expected to be generated by EMP.

Because of the uncertainty about the effects of EMP on commercial nuclear plant shutdown capability, the NRC will conduct a study of these effects and how they can be avoided or mitigated.

II. GENERAL DESCRIPTION OF NRC STUDY PLAN

Objective

The study will have the following objectives: (1) to determine the vulnerability of selected safe shutdown systems of a specific nuclear plant to EMP effects due to nuclear weapons and non-nuclear generators, (2) to determine how those safe shutdown systems vulnerable to EMP may best be hardened against EMP, (3) to characterize to the extent possible the effects of EMP on nuclear plants in general based on the study of specific systems of the subject plant.

Organizational Responsibilities

The overall effort will be under direction of the Division of Systems Integration of the Office of Nuclear Reactor Regulation. NRC will be aided in directing the study by the Defense Nuclear Agency (DNA).

The NRC will employ a contractor to undertake those aspects of the study requiring knowledge of the design, construction, and operation of nuclear plants. The DNA will employ contractors to undertake those aspects of the study requiring knowledge of the effects of EMP and the methods of hardening against EMP. The specific tasks assigned to these contractors are described in Section III.

Review Panel

A panel of experts, each of whom is familiar with EMP or nuclear plants, will regularly review the progress of the study. The review panel will provide independent judgment of the validity of the conclusions of the study and can recommend additional tasks or studies to be pursued by the contractors at the discretion of the NRC. Meetings will be held at approximately two month intervals.

Plant Chosen For Study

TVA has agreed to assist in the study and will choose a TVA PWR as the subject plant. The plant systems to be evaluated are discussed in Section IV.

Duration of Study and Schedule

The overall goal is to complete all program objectives by May 1, 1982. In addition, the NRC and DNA contractors will be requested to determine the vulnerability of the systems necessary for decay heat removal to hot shutdown and to develop necessary hardening recommendations for these systems by October 1, 1981.

An outline of the currently projected schedule is given in Table 2. A more detailed schedule will be prepared by the contractors.

Additional Studies

If, after the initial study is complete, the information available is insufficient to arrive at conclusive judgments regarding the general vulnerability of nuclear plants to EMP, a plan for further studies will be developed. The studies may involve evaluation of BWR, human factors in responding to an EMP induced event, additional systems for a PWR, and computer protection systems.

III. NECESSARY TASKS AND RESPONSIBILITIES IN THE STUDY OF THE INTERACTION OF EMP WITH NUCLEAR POWER PLANT SYSTEMS

1. Identify the reactor plant systems or functions for which EMP vulnerability is to be addressed; indicate the priority or sequence in which these systems are to be investigated. (NRC Staff)

2. Identify the electrical components needed to operate those systems or to perform those functions specified in Step 1. (NRC Contractor)*

3. Determine the physical configurations of the structure housing the subject system, the arrangement of power cables and conductors entering these structures or connected to the system, or any other characteristic by which EMP can be coupled to the electrical components identified in Step 2. (NRC Contractors working with DNA Contractors)*

4. Based on justifiable assumptions regarding EMP sources and the information from Step 3, determine the EMP induced currents and voltages to which the electrical components of Step 2 will be subjected. (DNA Contractor)

5. Investigate and make a judgment of the validity of determining bounding values of currents and voltages for evaluating vulnerability of components during the remainder of the study. (DNA Contractor)

6. Based on the information from Step 4, determine whether the electrical components of the subject system will malfunction and/or be permanently damaged due to EMP. (NRC Contractor)

7. For each system with malfunctioning or failed components, determine whether the component malfunctions or failures will prohibit the system from fulfilling its intended functions. (NRC Contractor)

8. For those systems which will fail to function due to an EMP identify hardening alternatives and determine a recommended choice taking into account effectiveness and cost. (DNA Contractor)

9. Determine the impact of recommended hardening against EMP on the system performance and reliability in the absence of EMP. (NRC Contractor)

10. Based on the analysis of the effects of EMP on a specific set of plant systems and functions as outlined above, and on the similarities and differences between those systems and comparable systems at other plants, characterize the effects of EMP on nuclear plants in general including a judgment as to whether nuclear plants will retain safe shutdown capability subsequent to an EMP. (NRC Contractor and NRC Staff)

*TVA's contribution is essential to the successful completion of this task.

11. Upon request of the NRC, perform additional studies based on (a) information generated during the investigation (b) recommendations of the Review Panel. (NRC Contractors and DNA Contractors)

12. Prepare a report summarizing the above studies, including findings and recommendations. (NRC Staff and NRC Contractors)

IV. PLANT SYSTEMS TO BE EVALUATED

The plant systems to be evaluated will be chosen from those systems which must function properly to bring the plant to a stable condition such as hot shutdown or cold shutdown. A representative sample of plant electrical equipment should be included but the number of systems evaluated and the depth of the evaluation of some systems will be limited, if necessary, to meet the overall program schedule.

A preliminary selection of systems or functions to be evaluated is given in Table 1. The Priority I systems are primarily associated with achieving decay heat removal to hot shutdown; the Priority II systems are associated with achieving cold shutdown, reactivity control, and prevention or control of loss of coolant. Table 1 is subject to changes based on selection of a specific plant.

The success of the program is not predicated on the evaluation of all the systems listed in Table 1. Modifications to the extent and sequence of systems to be evaluated may become desirable during the study as a better understanding of the nature and difficulty of the problem is gained. Such modifications will be consistent with the objectives and schedule of the program.

TABLE 1 PWR SYSTEMS AND FUNCTIONS TO BE CONSIDERED IN EMP STUDY

Priority I

(1) AC and DC Emergency Power

(2) Auxiliary Feedwater System

(3) Atmospheric Steam Relief Valves

(4) Monitoring Systems (steam generator level and pressure, pressurizer level and pressure)

(5) Steam Generator Isolation

(6) Boration System

(7) Service and Cooling Water System

(8) Instrument Air

(9) Ventilation Systems for the Above

Priority II

(1) Power Operated Relief Valves

(2) Residual Heat Removal System

(3) Pressurizer Heaters and Sprays

(4) Charging and Letdown Systems

(5) Reactor Protection System

(6) Communications Network For Coordinating Shutdown by Operators

(7) Offsite Power

(8) High Pressure Injection System

(9) Engineered Safeguards Actuation System

(10) Post Accident Monitoring Instruments

TABLE 2 SCHEDULE FOR INVESTIGATION OF INTERACTION BETWEEN EMP AND NUCLEAR PLANT SYSTEMS

Milestone	Completion Date
Select Plant and Indentify Systems for Study	1 Sept 1980
Initial Plant Visit	1 Oct. 1980
Characterization of Coupling Modes for Priority I Systems	1 Jan. 1981
Evaluation of EMP Induced Currents and Voltages for Priority I Systems	1 April 1981
Determination of Failure Potential For Priority I Systems	1 July 1981
Hardening Recommendations for Vulnerable Priority I Systems	1 Oct. 1981
Determine Impact of Hardening on Priority I System Reliability	1 Dec. 1981
Completion of Study Through Task 9 for Priority II Systems (As Allowed By Time and Resources)	1 Feb. 1982
Report on Potential Impact of EMP on Nuclear Plants in General	1 March 1982
Final Report Including Recommendations	1 May 1982