NOV 24 1981

Mr. Wendell H. Marshall
Route 10
Midland, Michigan 48640

Dear Mr. Marshall:

This is in response to your mailgram of October 1, 1981 in which you inquire as to the potential effects of electromagnetic pulse (EMP) on nuclear power plants and express your belief that construction of the Midland Plant, Units 1 and 2, should be terminated pending resolution of this matter.

We understand your concern to be that EMP from a high altitude nuclear weapon detonation can induce electrical transients in the instrumentation, control and power lines of nuclear power plants. The extent to which these EMP transients may cause critical plant electrical and electronic systems to fail or malfunction and ultimately result in damage to the reactor is not known. A single EMP could affect most of the nuclear power plants in the continental United States. EMP-like effects can also be simulated locally using truck-transportable land based generators.

The NRC Regulations (10 CFR 50.13) state that license applicants are not required to provide design features or other measures for the specific purpose of protection against the effects of (a) attacks and destructive acts; including sabotage, directed against the facility by an enemy to the United States, whether a foreign government or other person, or (b) use or deployment of weapons incident to U. S. defense activities.

The issue is documented in report NUREG-0153, "Staff Discussion of Twelve Additional Technical Issues Raised by Responses to November 3, 1976 Memorandum from Director, NRR to NRR Staff", December 1976. It is identified as Issue 27 (copy enclosed) in NUREG-0153. The enclosure indicated, at that time, that some general studies had been conducted and that the most likely consequence would be an unscheduled plant shutdown with some likelihood that portions of protection systems might be affected. The report concluded that design provisions for protection against the effects of EMP are not required by our regulations and that consideration of this issue did not warrant revision of any existing licenses.

Nevertheless, since there is some likelihood of EMP effect, the NRC subsequently initiated an investigation of the EMP effects on nuclear power plants, which is now approximately 40% complete and which is scheduled for completion in 1982. The objectives of the investigation are: (1) to determine the vulnerability of selected safe shutdown systems of a specific nuclear plant to EMP effects due to nuclear weapon detonations and non-nuclear generators, (2) to determine how those safe shutdown systems vulnerable to EMP may best be hardened against EMP, and (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. The overall objective is to provide a basis for considering the need for amending the regulations to include design requirements for the protection of nuclear power plants against the effect of EMP.

Our investigation is proceeding with the technical assistance of Sandia National Laboratory (SNL). The TVA Watts Bar plant was selected for the study. The program includes EMP coupling analysis, evaluation of failure threshold of selected safety equipment, and an onsite test program to obtain data for confirmation of the results of analyses. SNL and its subcontractors have all performed similar work for the Department of Defense (DOD) concerning the EMP vulnerability of military facilities. The Defense Nuclear Agency of the DOD is participating in this program to provide assurance of the technical validity of the conclusions and recommendations. Additional assurance will be provided by a panel of independent experts which has been established to review the progress and results of the program.

EMP concerns during the peacetime operation of nuclear power plants derive from EMP which could be produced by terrorist actions involving nuclear weapon detonations or non-nuclear generators, or which could result from accidents involving U. S. or foreign nuclear weapons systems. Our preliminary conclusion is that a significant threat does not exist from non-nuclear generators because of the difficulty of deploying and operating such equipment in the vicinity of a plant without being detected, and because the effects of this type of equipment are low level and highly localized.

In conclusion, because the NRC regulations do not require protection against nuclear weapons, and because our preliminary conclusions reveal no significant threat from non-nuclear generators, we find insufficient support for your belief that construction of the Midland Plant should be suspended. Additionally, it should be noted that the Midland Plant is presently about 70% complete and most of the items which would be of the EMP concern are already installed. Should

the results of our ongoing investigation result in revisions to the regulations or indicate the need for improved EMP protection, Midland, like other nuclear plants, would be considered in the implementation planning of the regulations.

Sincerely,

(Signed) T. A. Rehm

William J. Dircks
Executive Director for Operations

Enclosure:
NUREG-0153 (Issue 27)

cc: Rep. Don Albosta
Sen. Carl Levin

STAFF DISCUSSION OF TWELVE ADDITIONAL TECHNICAL ISSUES RAISED BY RESPONSES TO NOVEMBER 3, 1976 MEMORANDUM FROM DIRECTOR, NRR TO NRR STAFF

Date Published: December 1976

Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

ISSUE 27

EFFECTS ON UTILITY TRANSMISSION SYSTEMS OF THE EXPLOSION OF A LARGE NUCLEAR WEAPON

This issue was identified by Demetrios Basdekas in a memorandum dated November 19, 1976, to Ben C. Rusche in response to Mr. Rusche's memorandum dated November 3, 1976, requesting that staff members identify any significant safety issues they believe are presently being treated inadequately by the staff. The matter was discussed on December 6, 1976, with Mr. Basdekas to determine whether or not further definition was necessary or desirable. As a result of this discussion, it was determined that some changes to the statement would be appropriate. This issue, as originally defined in Attachment 4 to Mr. Basdekas' November 19, 1976 memorandum to Mr. Rusche, has been redefined to read as follows:

> We are working" on this problem but we are not doing anything in terms of regulatory requirements for applicants to start addressing this aspect of nuclear weapons effects. Considering that EMP may represent the largest common mode failure event imaginable, NRC should assume a leading and aggressive role in addressing this issue.
>
> Particular attention should be given to EMP effects on solid State Safety equipment and ESF electrical power and control systems.

Summary of Issue

The electromagnetic pulse (EMP) produced by a high altitude nuclear detonation would induce adverse current and voltage transients in

electrical conductors. Such fields that may be created would couple some EMP energy to circuits in a nuclear power plant, and might cause common mode failures significant to safety.

Summary Response

NRC Regulations do not require consideration in the licensing and safety review of nuclear power plants of effects due to hostile actions of foreign powers. It is presumed that these actions will be dealt with by the Defense Department with regard to protection of domestic facilities. Therefore, the staff does not make detailed analyses of the possible effects on nuclear power plants of EMP from postulated nuclear explosions. Some general studies have been conducted by Oak Ridge National Laboratory regarding the effects of EMP on a PWR. They found that the most likely consequence of EMP for a PWR plant is an unschedlued shutdown, but some portions of the electrical and protection systems might be vulnerable to the effects of EMP.

Detailed Discussion

Nuclear power plants are designed to mitigate the consequences of postulated accidents and to protect the health and safety of the public. The staff, as part of its evaluation of postulated accidents, assumes that a single active failure occurs in systems required to mitigate

the consequences of such events. The probability of multiple random failures involving two components or more coincident with an accident, is considered to be too small to have any significance. However, in the case of an EMP, a great deal of equipment, in principle, could be affected and subject to a possible common mode failure.

10 CFR Part 50.13 states that:

> "An applicant for a license to construct and operate a production or utilization facility, or for an amendment to such license, is not required to provide for design features or other measures for the specific purpose of protection against the effects of (a) attacks and destructive acts, including sabotage, directed against the facility by an enemy of the United States, whether a foreign government or other person, or (b) use or deployment of weapons incident to U. S. defense activities."

Accordingly it has been, and remains, the staff's policy not to require detailed analyses of the possible effects on nuclear power plants of EMP from nuclear detonations (the only potential source of significant EMP).

Electromagnetic pulses from nuclear detonations are produced in the earth's atmosphere as a result of high energy gamma rays interacting with atmospheric gases providing a field of high energy Compton recoil electrons. In the presence of the earth's magnetic field, these Compton electrons are influenced in such a way that a Compton current develops which becomes the primary source of the EMP field. For high altitude

detonations, the EMP can affect very large areas of the country; e.g., one megaton detonations over central U.S.A. at altitudes of 100 and 400 km could affect the entire area of the U.S.A. Low altitude detonations are much less effective for EMP; e.g., the blast may be the only effect over a few kilometers range.

ORNL has prepared two reports on this subject: "Transient Response of Nuclear Power Plant Cables to High-Altitude Nuclear Electromagnetic Pulse (EMP)," ORNL-5156, P. R. Barnes and J. H. Marable, May 1976, and "The Effects of Nuclear Electromagnetic Pulse (EMP) on Nuclear Power Plants," (draft) ORNL-8029, P. R. Barnes and R. W. Manweiler. The authors of these reports, conclude that a nuclear power plant would probably survive exposure to an EMP without any risk of a reactor accident. In all nuclear power plants, the reactor and some of the protection system circuitry are located within the containment building, which is either built of steel plate or is a concrete structure lined with steel plate. In both cases, the shielding from EMP provided by the steel plate is excellent and there should be no adverse effects within the containment structure. However, a substantial part of the protection system circuitry is outside the containment, in the control room, the cable spreading room, and in portions of the auxiliary building where essential auxiliary systems are located.

The control room and auxiliary buildings are normally constructed of reinforced concrete, of heavy construction since they are

built to withstand tornado missiles, differential pressures and seismic events. The multiple courses of reinforcing bars in the walls and ceilings of these structures should provide substantial attenuation of EMP. It appears that up to 30 to 40 db of attenuation are available from this sort of heavily reinforced concrete construction. Further shielding is provided by steel cabinets, cable raceways, and electrical conduits for wire and cable runs inside these structures.

The ORNL reports find that the most serious effects would be on digital logic circuits. They find that analog-type control circuits are more resistant to pulse damage. There is also a strong effect from large pulses on solid state circuitry, because the solid state elements (diodes, transistors, etc.) are typically unable to accept large temporary overloads as are vacuum tube elements. Digital computers with solid state components are probably the most vulnerable kind of equipment to EMP exposures.

The ORNL reports note that a high altitude nuclear burst, with resulting EMP, could cause the transmission grid to fail over a large area. Nuclear plants are not dependent upon off-site power for safe shutdown, so this in itself should not be of any particular concern. If the emergency power diesel generator control and starting circuitry is exposed, it could be vulnerable to the effects of EMP. Also, the solid state control elements in the station battery circuits might be vulnerable to EMP if they are located in the open or are directly connected to lines leading out into the switchyard which would pick up substantial voltage pulses from EMP.

...ion, design provisions for protection against the effects of EMP are not required by our regulations, and such effects are not reviewed as part of our safety evaluation of nuclear power plants. The staff concludes that consideration of this issue does not warrant revisions of any existing licenses or changes in staff priorities.

ALL COMMENTS RECEIVED FROM

INDIVIDUALS

IN RESPONSE TO

MEMORANDA FROM DIRECTOR, NRR

DATED DECEMBER 17, 20, 21, 22 or 27, 1976

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

DEC 20 1976

MEMORANDUM FOR: Benard C. Rusche, Director
Office of Nuclear Reactor Regulatory

FROM: Demetrios L. Basdekas
Experimental Fast Reactor Safety Research

SUBJECT: YOUR MEMORANDUM TO ME DATED DECEMBER 17, 1976 ON THE STAFF DISCUSSION OF SAFETY ISSUES NO. 22 THROUGH 27.

My preliminary comments on the subject safety issues are given in Attachments 1 through 6 to this memorandum. This initial response is provided according to your request by close of business today. In view of the inordinate time limitation my comments could not be as detailed or complete as the issues warrant.

You indicated in the subject memorandum that the final staff discussion paper on these issues will be issued sometime before January 3, 1977. I am looking forward to receiving a copy of it, and I will be prepared to discuss these issues with ACRS if you determine this to be desirable.

Demetrios L Basdekas.

Demetrios L. Basdekas
Experimental Fast Reactor Safety Research
Division of Reactor Safety Research

Attachments:
As Stated

cc: C. N. Kelber, RSR

PDR (LFDCB) Dupe # E10522004?

Attachment # 6
DEC 20 1976

ISSUE 27

EFFECTS ON UTILITY TRANSMISSION SYSTEMS OF THE EXPLOSION OF A LARGE NUCLEAR WEAPON

The title of this Issue should be changed to read as follows:

ELECTROMAGNETIC PULSE EFFECTS OF A HIGH ALTITUDE EXPLOSION OF A NUCLEAR WEAPON ON SAFETY-RELATED EQUIPMENT OF NUCLEAR POWER PLANTS.

The present title is very restrictive and misleading and it does not reflect the extent of the concern expressed.

With the introduction of more and more solid state and digital electronic equipment in the safety-related systems the vulnerability of nuclear power plants to EMP effects is increasing and the attendant consequences to public health and safety should be systematically analyzed. I reiterate my earlier position that NRC should assume a leading and aggressive role in addressing this issue, so that, in many instances, simple design features might provide adequate protection, or "hardening" of the vulnerable equipment.

The arguments presented by the Staff under "Summary Discussion" on page 27-2 to the effect that "everything is allright" are very superficial.

If it is necessary to change some printed words in 10 CFR part 50.13 cited on page 27-3 then this will have to be done too.

I agree with the last statement made on the second paragraph page 27-5 that "Digital computers with solid state components are probably the most vulnerable kind of equipment to EMP exposures." This is most relevant to the discussion of Issue No. 14. It is also timely that this fact be considered now while these new generation of Reactor Protection Systems are under review.

Because of the time constraints a complete discussion of all points of disagreement is not possible at this time. However, I will be happy to discuss this safety issue at an appropriate time and forum.