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

October 30, 1978

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Atomic Safety and Licensing Board
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Mr. Lester Kornblith, Jr.
Technical Adviser
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U.S. Nuclear Regulatory Commission
Washington, DC 20555

Dr. David R. Schink
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In the Matter of
Public Service Electric and Gas Company
(Atlantic Nuclear Generating Station, Units 1 and 2)
Docket Nos. STN 50-477, STN 50-478

Gentlemen:

Enclosed is a memorandum from the Director of the Office of Nuclear Reactor Regulation to the Commissioners dated September 29, 1978, discussing the results of a recently conducted fire protection research test by the Underwriters Laboratory for the Commission as part of the NRC's fire protection research program.

If the Board or the parties wish any additional information, please let us know.

Sincerely,

Stephen M. Sohinki
Counsel for NRC Staff

Enclosure: As Stated

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Docketing and Service Section

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

September 29, 1978

MEMORANDUM FOR: Chairman Hendrie
Commissioner Gilinsky
Commissioner Kennedy
Commissioner Bradford
Commissioner Ahearne

THRU: Executive Director for Operations

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

SUBJECT: NRC FIRE PROTECTION RESEARCH TEST

On September 15, 1978, a fire test of a full-scale vertical cable tray array was conducted at the Underwriters' Laboratory near Chicago, Illinois. It was part of the NRC-expedited fire protection research program requested in the Commission's Order of April 13, 1978. The purpose of the test was to demonstrate the effectiveness of area sprinklers and mineral wool blanket type cable tray fire barriers in preventing damage to cables as a result of an exposure fire created by igniting two gallons of heptane.

The configuration of cables and fire protection features in the test did not simulate any particular nuclear power plant. There are plants in operation and under construction for which the electrical cable tray configuration of the test was typical. However, based on the staff's ongoing fire protection reviews, we know of no operating plants with the configuration of fire protection features used in the test, although features of this type have been proposed for installation and are currently under review by the staff.

The test resulted in damage to some of the electrical cables. Preliminary analysis (see Enclosure 1) indicates that the configuration of fire protection features used in the test would not be acceptable for application in nuclear power plants. In particular, it appears that fire barriers for vertical trays in some configurations may need to be designed to prevent entry of flammable fluids. A wick effect may also need to be considered in the design of fire barriers. The response of the fusible link sprinklers used in the test is also under further study.

The test results are still being analyzed and it would be premature to establish firm conclusions at this time; however, the results now available suggest that modifications to certain of the staff's fire protection criteria may be necessary. The staff is continuing its review and will meet with the test contractors (Sandia and UL) on October 3, 1978 to further study the preliminary findings and results. A quick look report is expected to be completed by UL within the next several days and will be issued by Sandia shortly thereafter. The schedule and nature of further testing under this program are under review.

We will keep the Commission informed of significant results and possible impacts on operating reactors as information becomes available. A circular or bulletin will be issued by IE to inform licensees of the results of the test. Its preparation will follow the October 3 meeting with the contractors. Plants currently in operation remain subject to administrative procedures aimed at minimizing the sources of ignition and continue to maintain manual fire fighting capability.

We will inform the Commission of any action deemed necessary as a result of our continuing review of the test results. The public announcement provided in Enclosure 2 is planned for release by the Office of Public Affairs on October 2. We are in the process of informing the ACRS and Hearing Boards where this information is relevant.

Harold R. Denton

Harold R. Denton, Director
Office of Nuclear Reactor Regulation

Enclosures:
1. Preliminary Analyses
2. Public Announcement

cc: (w/encls.)
Union of Concerned Scientists
Office of the Secretary
NRC Public Document Room

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

SEP 27 1978

MEMORANDUM FOR: Robert L. Tedesco, Assistant Director
for Plant Systems
Division of Systems Safety

FROM: Gregory A. Harrison
Auxiliary Systems Branch
Division of Systems Safety

Philip R. Matthews, Section Leader
Auxiliary Systems Branch
Division of Systems Safety

THRU: Victor Benaroya, Chief
Auxiliary Systems Branch
Division of Systems Safety

SUBJECT: UL FIRE PROTECTION TESTS

On September 15, 1978, Underwriters Laboratory conducted a full scale vertical cable tray fire test including fire barriers and sprinklers. The source of the fire was two gallons of heptane liquid. This test was part of the expedited fire protection research program as requested in the Commission's order of April 13, 1978. The purpose of the test was to demonstrate the effectiveness of area sprinklers and cable tray fire barriers in preventing damage of safety significance to the cable circuits due to exposure fire conditions.

The configuration of the fire test was selected to simulate a section of a plant area with vertical cable trays containing redundant safety divisions arranged such that the redundant divisions could be simultaneously exposed to a potential fire resulting from an inadvertent spill of flammable liquid in the area. The arrangement of the cable trays and the designation of the redundant tray divisions is shown in Figure 1 taken from the User Request Memorandum.1/ Figure 2 shows the location of the fire detectors and the three groups of sprinklers. Each of the five cable trays was enclosed in a separate mineral wool blanket fire barrier from floor to ceiling in accordance with the manufacturers specifications currently recommended to their customers. The sprinker and detector arrangement was as permitted by NFPA Code.

1/ User Request Memorandum dated June 1, 1978, from E.G. Case, NRR to S. Levine, RES

Enclosure 1

Each sprinkler location contained three nominally identical temperature sensing sprinkler heads with fusible links adjacent to an open sprinkler head which was connected to a manual water supply valve. The temperature sensing heads were wired to signal when their links fused. After all three temperature sensing heads at a given location activated, then the water supply for the open head was to be manually admitted. The sprinklers were of a type which actuate at the slow end of acceptance for reaction time. The test procedure required that all three temperature sensing heads had to activate before water would be turned on. In this way it was expected to get some data on variability in the response time of identical sprinklers. A detailed description of the test set up and procedure will be in the UL test report which will be issued later. It was agreed that the demonstration would be considered to have no safety significance if the electrical circuits did not fail in more than one tray.2/

The following summary of the test results is based on direct observation of the test by NRC staff. Test data are still being correlated by UL and will be included in their Quick Look Report to be issued to Sandia for its review shortly.

The test was started by igniting the two gallons of heptane that was poured into the floor pan. A fully developed fire occurred almost immediately. The ceiling smoke detector alarmed in about 15 seconds. In about 50-60 seconds, two of the three temperature sensing sprinklers located between the wall and cable trays 1 and 2 activated. The fire between cable trays 1, 2, 3, and 4 appeared most intense apparently because of a chimney effect between the four trays. The flames between cable trays 3 and 5 did not appear to be so intense. The mineral blanket absorbed some of the heptane so that after the heptane in the pan burned, most of the flame seemed to come from the bottom outside surface of the mineral blanket. No additional temperature sensing sprinkler heads at any location activated; thus, the sprinkler water supply was not turned on for any of the three sprinkler locations. No water was used at any time during the test. The apparent slow response of the third temperature sensing sprinkler is being investigated.

2/ Memorandum dated September 13, 1978, from V. Benaroya and G. Lainas to G. Bennett

At about 3 minutes there was an indication of a short circuit in cable trays 3, and after 7 minutes indication of a short in tray 1. After 5-7 minutes the height of the flames appeared to subside; however, residual flames continued for about 40 minutes. It was reported that apparently the highest measured temperature inside any cable bundle was less than 150 F; however, damage to the cables indicates that higher temperatures were reached in the trays at the bottom regions, below the location of the thermocouples.

Test results are still being analyzed and no firm conclusions can be drawn at this time. Preliminary information received from RES subsequent to the test indicates that the flammable liquid or flames penetrated an opening in the protective barriers at the bottom of the vertical trays and caused fire damage to the PVC cables in four of the five trays. The electrical short to ground that occurred in cable tray 3 probably was caused by the fire. The second electrical short in tray 1 apparently was caused by a broken instrument connection, and is not considered to be related directly to the fire. On subsequent 500-volt megger tests, it was found that another cable in tray 2 had also experienced some damage.

The most probable cause of the fire damage in certain cable trays appears to be related to the absorption and/or seepage of heptane under the mineral wool blanket at the juncture with the floor. Once the heptane entered the interior regions of the cable tray, then ignition apparently occurred via the small opening at the floor or through a vapor/air path within the joints. It is believed that this type of failure mode could be prevented by using a seal material that would prevent the absorption or the seepage of heptane under the mineral wool blanket. There is some indication that some cable damage was caused by absorption of the inside of the barrier (wicking effect) which heated a cable tray ladder, causing damage to a cable in contact with the ring. The investigation of the results is still underway, and while no definitive findings can be stated, damage did occur to cables in several trays due to the fire. The slow response of the sprinkler system was not predicted. The ingress of the heptane into the mineral wool needs to be further evaluated since this appears to be the most significant failure mode.

The test results are still being analyzed and it would be premature to establish firm conclusions at this time; however, the results now available indicate: (a) fire detectors located approximately 15 feet away from the fire promptly ($\sim$15 sec) detected the fire; (b) some small fires may not actuate sprinkler heads; and (c) protective barriers should be designed to prevent the entry of flammable liquids.

The staff plans to meet with personnel from Sandia and LL during the first week of October. A Quick Look Test Report is expected to be released in early October.

It does appear that further evaluation of the results may lead to the formulation of supplemental fire protection requirements concerning seals and types of sprinkler heads to be used. In view of this, it is appropriate to notify the ACRS, the Commission, and any Boards, where this issue is relevant, as to the current situation. We will continue our evaluation of the test results and consideration of new additional tests to be conducted. A public announcement has been prepared by the Office of Public Affairs (Enclosure 3) and is to be released September 29, 1978.

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cc: R. Mattson
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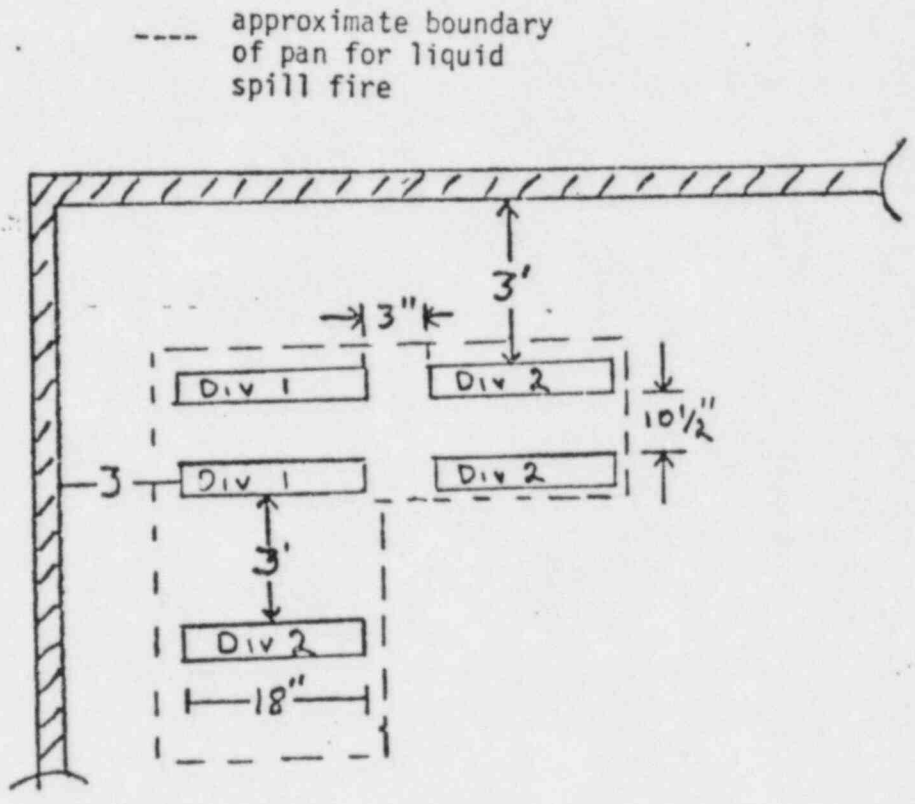
Figure 1



Vertical Tray Corner Test

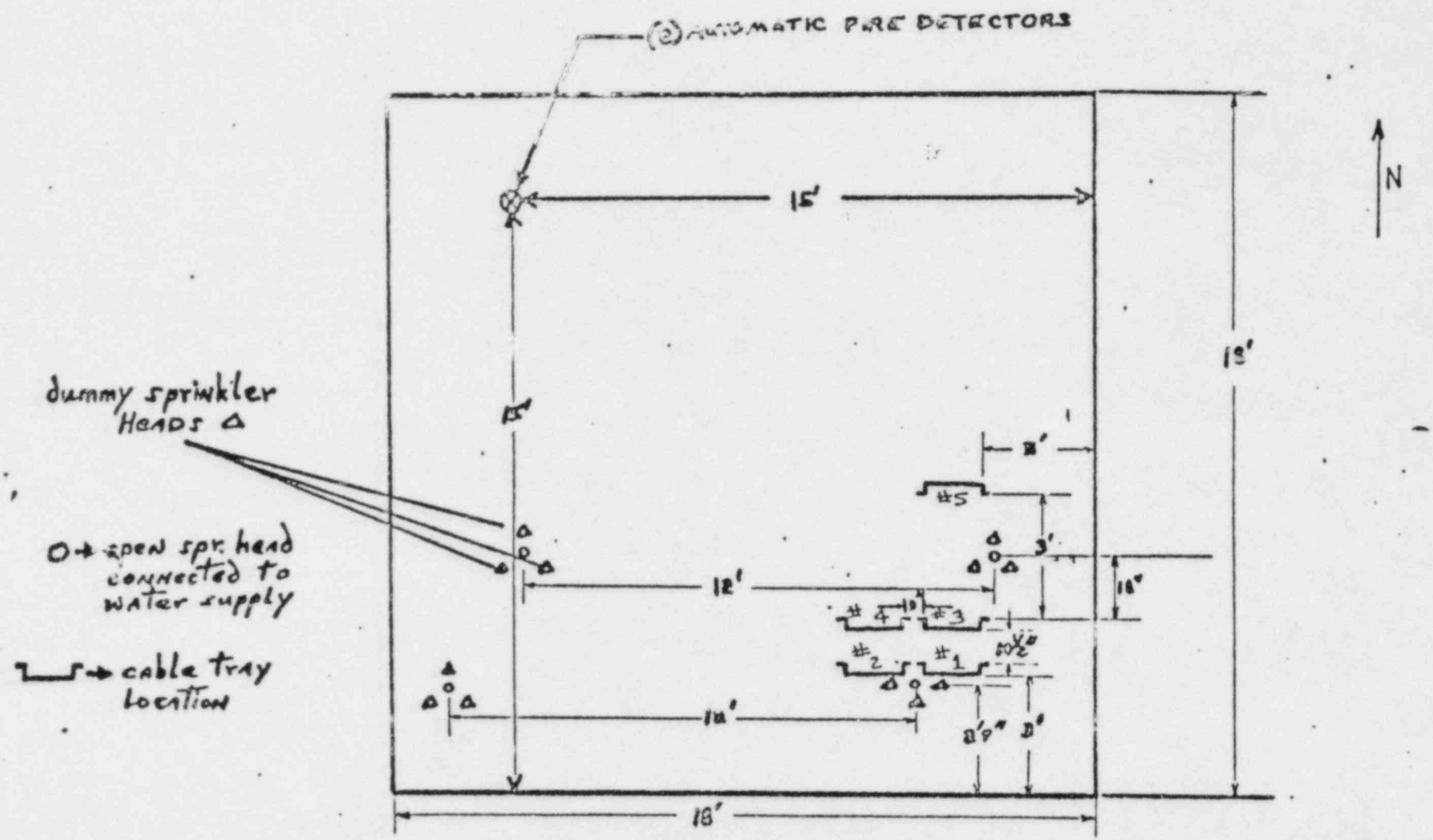


FIGURE 2
TOP VIEW GENERAL

PUBLIC ANNOUNCEMENT

NRC Staff Evaluating Results of Test
of Fire Protection Systems

The staff of the Nuclear Regulatory Commission (NRC) is evaluating the results of a recent test of fire suppression systems to determine whether changes should be made in NRC fire protection criteria for nuclear power plants.

As part of NRC's research program, the test was conducted at Underwriters' Laboratory (UL) near Chicago on September 15, 1978. The test involved electrical cables in five vertical trays and included fire barriers and water sprinklers. The test resulted in damage to some of the electrical cables. Preliminary analyses indicate that the fire barrier and sprinkler configuration used in the test would not by itself be acceptable fire protection in nuclear power plants.

As a result of the fire at the Browns Ferry Nuclear Plant in Alabama in 1975, the NRC has imposed strict administrative controls over fire ignition sources at all nuclear power plants, and manual firefighting capability has been strengthened. Fire suppression systems of the type tested at Underwriters' Laboratory are among those being reviewed for further strengthening of fire protection in these plants. Although some plants already have sprinkler systems, and many rely on various types of fire barriers, the NRC staff knows of no present use of the system tested at Underwriters' Laboratory.

Enclosure 2

A configuration of five, full-scale vertical cable trays containing electrical cables simulating redundant safety systems was used in the test. Each of the cable trays was enclosed, from floor to ceiling, in a separate fire barrier of mineral wool. Three groups of sensing sprinkler heads were wired to signal when their heat sensitive links fused from the heat of the fire. The manually operated sprinkler then was to be actuated. In actual plant applications, each fusible link would actuate one sprinkler head.

A fire was started in a pan on the floor and an alarm was sounded by a ceiling detector about 15 seconds later. During the test two of three links in one sprinkler location fused; none of the other links fused and, consequently, no water was used to extinguish the fire. In addition, it appears that some of the flammable liquid used as the fire source seeped under the blanket and was absorbed, resulting in damage to the cables at the bottom of the cable trays.

Preliminary analysis indicates there was some fire damage to cables in four of the five trays. Addition of a seal material might have prevented the damage resulting from the absorption or seepage of flammable liquids under or into the mineral blankets. However, the tests appear to have confirmed that blankets can be an effective heat barrier. The performance of the sprinkler links is still being analyzed. Upon completion of the analyses, the NRC staff will inform licensees of the results.

These analyses may lead to new requirements for the type of fusible links which can be used in sprinkler heads, as well as for sealants for fire barriers. In the interim, the NRC staff believes existing fire protection requirements--including administrative controls over ignition sources and the presence of fire brigades at the plants--provide adequate protection.