March 21, 1985

DMB 01

Docket No. 50-346

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Mr. Richard P. Crouse
Vice President, Nuclear
Toledo Edison Company
Edison Plaza - Stop 712
300 Madison Avenue
Toledo, Ohio 43652

Dear Mr. Crouse:

SUBJECT: REDUNDANT SFAS CHANNEL INDEPENDENCE; REQUEST FOR ADDITIONAL INFORMATION

On December 5, 1980, an inadvertent Safety Features Actuation System (SFAS) actuation occurred at the Davis-Besse Nuclear Power Station. Subsequent investigation revealed that hardwired electrical interconnections exist between the circuitry associated with SFAS instrument and logic channels 1 and 3 and channels 2 and 4. Our review of the design of the SFAS, specifically with respect to this instrumentation and your proposed grounding of the floating commons, is not complete. To continue our review, we require additional information as identified in Enclosure 1 to this letter. Please provide the requested information no later than May 13, 1985.

Enclosure 2 presents background information regarding the staff concerns on SFAS channel independence at Davis-Besse.

The information requested in this letter affects fewer than ten respondents; therefore, OMB clearance is not required under P.L. 96-511.

Sincerely,

"ORIGINAL SIGNED BY
JOHN F. STOLZ"

John F. Stolz, Chief
Operating Reactors Branch #4
Division of Licensing

Enclosure:
Request for Additional
Information

cc w/enclosure:
See next page

ORB#4:DL	ORB#4:DL
ADe Agazio;cf	JStolz
3/21/85	3/21/85

Toledo Edison Company

cc w/enclosure(s):

Mr. Donald H. Hauser, Esq.
The Cleveland Electric
Illuminating Company
P. O. Box 5000
Cleveland, Ohio 44101

Gerald Charnoff, Esq.
Shaw, Pittman, Potts
and Trowbridge
1800 M Street, N. W.
Washington, D. C. 20036

Paul M. Smart, Esq.
Fuller & Henry
300 Madison Avenue
P. O. Box 2088
Toledo, Ohio 43603

Mr. Robert B. Borsum
Babcock & Wilcox
Nuclear Power Generation
Division
7910 Woodmont Avenue
Suite 220
Bethesda, Maryland 20814

President, Board of County
Commissioners of Ottawa County
Port Clinton, Ohio 43452

Attorney General
Department of Attorney General
30 East Broad Street
Columbus, Ohio 43215

Harold Kahn, Staff Scientist
Power Siting Commission
361 East Broad Street
Columbus, Ohio 43216

Mr. James G. Keppler, Regional Administrator
U. S. Nuclear Regulatory Commisison, Region III
799 Roosevelt Road
Glen Ellyn, Illinois 60137

Mr. Robert F. Peters
Manager, Nuclear Licensing
Toledo Edison Company
Edison Plaza
300 Madison Avenue
Toledo, Ohio 43652

U. S. Nuclear Regulatory Commission
Resident Inspector's Office
5503 N. State Route 2
Oak Harbor, Ohio 43449

Regional Radiation Representative
EPA Region V
230 South Dearborn Street
Chicago, Illinois 60604

Ohio Department of Health
ATTN: Radiological Health
Program Director
P. O. Box 118
Columbus, Ohio 43216

James W. Harris, Director (Addressee Only)
Division of Power Generation
Ohio Department of Industrial Relations
2323 West 5th Avenue
P. O. Box 825
Columbus, Ohio 43216

Enclosure 1

DAVIS-BESSE: INDEPENDENCE BETWEEN REDUNDANT SFAS INSTRUMENT AND LOGIC CHANNELS - REQUEST FOR INFORMATION

1. Toledo Edison Company letters dated August 30, 1977 and September 16, 1977 responded to staff concerns regarding inadvertent ties between the instrument ground grid and the station ground grid at Davis-Besse. An analysis was provided which showed that plant safety systems will perform as intended given the worst postulated station electrical fault introducing ground currents into the station grounding grid, given that inadvertent ties exist between the instrument and station ground systems. The SFAS was excluded from the analysis because it included its own floating instrument ground separate from those systems with the instrument and station grounds connected (i.e., Reactor Protection System, Nuclear Instrumentation, Non-Nuclear Instrumentation Integrated Control System, etc.) Given that your proposed modification to resolve staff concerns regarding independence between redundant SFAS instrument and logic channels is to provide permanent grounding of the floating power supply commons to the instrument ground:

   (a) Verify that the SFAS (and SFRCS) will not be degraded below an acceptable level (i.e., will still perform their safety functions as designed) given the worst postulated station electrical fault (provide appropriate information/analysis supporting your conclusion), and

(b) Verify that any damage to SFAS components (as described in your letter of September 15, 1981) due to electrical faults subsequent to the proposed modification, will be limited to a single SFAS instrument/logic channel.

2. Toledo Edison Company letter dated March 11, 1983 stated that SFAS functional tests were performed with the power supply floating common between channels 1 and 3 grounded. The same test was repeated for channels 2 and 4. The tests were reviewed by the SFAS vendor, Consolidated Controls Corporation, and found to be acceptable. Describe these tests and indicate why they are sufficient to demonstrate SFAS operability with the floating commons permanently grounded. Provide the test results.

3. It appears that eliminating the interconnections (floating commons) between redundant SFAS instrument and logic channels, but maintaining the SFAS instrument ground separate from the station ground (i.e., each SFAS channel having its own floating common) would resolve staff concerns regarding separation between redundant SFAS channels, and would not subject the SFAS to problems from ground currents, or damage from electrical faults. Document the specific reasons for not taking this approach to resolve the SFAS channel independence issue.

4. Provide revised electrical schematic/elementary diagrams showing the Davis-Besse SFAS design following the proposed modifications. Also provide drawing E-470 showing the instrument grounding system, and a typical schematic/elementary diagram of a SFAS valve control circuit for a "fail-safe" valve where the use of floating returns common to redundant SFAS channels (i.e., 1 and 3, or 2 and 4) is used in the design.

Enclosure 2

BACKGROUND INFORMATION REGARDING STAFF CONCERNS ON INDEPENDENCE BETWEEN REDUNDANT SFAS CHANNELS AT DAVIS-BESSE

The purpose of this enclosure is to provide background information regarding the events that brought to the staff's attention the existence of electrical connections between redundant safety features actuation system (SFAS) instrument and logic channels at Davis-Besse, and the chronology of correspondence between the staff and the licensee to resolve staff concerns.

Following an inadvertent SFAS actuation at Davis-Besse on December 5, 1980, it was discovered that hardwired electrical connections exist between circuitry associated with SFAS instrument and logic channels 1 and 3. Specifically, the power supply returns (floating commons) for the ±15 Vdc and 24 Vdc supplies within the SFAS cabinets for channels 1 and 3 are electrically connected. Similar connections exist between SFAS channels 2 and 4. The Davis-Besse SFAS uses a 2-out-of-4 "deenergize-to-actuate" logic for the actuation of engineered safety features equipment. Each of four instrument/sensing channels (for each monitored SFAS parameter) provides an input to each of four logic channels. Each logic channel provides an output when any two or more of its inputs are in a tripped condition. The outputs of logic channels 1 and 3 are combined to form SFAS actuation channel 1 which initiates SFAS equipment in train 1. Similarly, SFAS logic channels 2 and 4 are combined to

form SFAS actuation channel 2 which initiates equipment in train 2. Both logic channels associated with an actuation channel must be tripped in order to cause an SFAS actuation. Prior to the SFAS actuation on December 5, 1980, a short circuit within a 15 Vdc power supply associated with SFAS instrument channel 1 resulted in 120 Vac on the shared (floating) return between channels 1 and 3. This caused bistable setpoints within both channels to deviate from their normal values, in some cases exceeding Technical Specification limits. This condition existed (went undetected) for several days prior to the SFAS actuation.

The staff's review of the interconnections between redundant SFAS channels raised the following concerns: 1) An electrical fault on a shared power supply return could potentially cause a spurious SFAS actuation, and 2) an undetected fault (the shared power supply returns are not continuously monitored for fault conditions) coupled with a single failure within a channel unaffected by the fault could potentially prevent a SFAS actuation when needed. The effect of a sustained (undetected) fault condition on SFAS circuit components has not been completely determined. The staff's review of the interconnections between redundant channels concluded that the Davis-Besse SFAS design (as a four channel system) may not comply with the requirements of Section 4.6 (Channel Independence) of IEEE Standard 279-1971. The Davis-Besse SFAS was described in the FSAR, review by the staff, and licensed as a four

independent channel system. Therefore, the staff requested the licensee (Toledo Edison Company - TED) by Reference 1 to provide the following information: 1) identify all power supply returns shared between redundant SFAS channels, 2) list the design requirements that necessitated these interconnections, and 3) provide a commitment and schedule for removing the interconnections, or provide an analysis supporting their retention. The intent of this request was to obtain the information necessary to determine what corrective actions needed to be taken at Davis-Besse to resolve staff concerns, and to provide input to IE regarding issuance of a Bulletin. It is our understanding that similar designs (supplied by Consolidated Controls Corporation) may exist at other facilities, including Millstone Unit 2 and St. Lucie Unit 2.

The TED response (Reference 2) to the above items 1) did not identify any additional interconnections, but failed to indicate that other interconnections do not exist, 2) indicated that the interconnections are used to reduce the number of contacts from SFAS relays and control switches, and to reduce the amount of field run wiring into the control room SFAS and steam and feedwater

rupture control system (SFRCS) cabinets, and 3) presented the Davis-Besse SFAS as a two channel (as opposed to four channel) design that complies with Section 4.6 of IEEE Std. 279. TED , however, acknowledged that their interpretation of Section 4.6 differed from that of the staff, and stated that in order to possibly resolve the staff's concerns regarding the common ties between redundant SFAS sensing/logic channels, the floating commons were temporarily connected to the instrument ground and the SFAS was functionally tested successfully. TED , however, cautioned that grounding the commons would result in significant potential hazards relating to system reliability, that ground faults or stray voltages occurring subsequent to grounding could potentially damage a sensor sub-channel, and concluded that this configuration poses a greater potential for SFAS damage and is considered highly undesirable.

Based on the review of the information provided in Reference 2, the staff concluded that the Davis-Besse SFAS as a two channel system may comply with the requirements of IEEE Std. 279, but that additional information would be required demonstrating that 1) the SFAS as a two channel system complies with the criteria defined in Section 7.3 of the Standard Review Plan, including

Section 6.3 of IEEE Std. 379 regarding spurious actuations, 2) the plant Technical Specification operability requirements and action statements (limiting conditions for operation) were consistent with a two channel SFAS design, including the minimum redundancy requirements of IEEE Std. 279 for when a SFAS channel is bypassed or removed from service, 3) the plant operating procedures are consistent with the two channel SFAS concept, and 4) that permanently installed continuous monitoring of the shared commons for fault conditions would be implemented, or justification provided demonstrating that continuous monitoring is not necessary. The above information was requested from TED via Reference 3. The staff concluded that interim operation was acceptable if continuous monitoring of the shared power supply returns was promptly implemented. To our knowledge, continuous monitoring of the returns has never been implemented. The licensee has instituted monthly surveillance testing to determine the presence of extraneous voltage on the SFAS commons. However, the staff does not believe that this frequency is sufficient to identify and correct fault conditions prior to adversely affecting components within redundant SFAS channels.

The TED response (Reference 4) did not provide the requested information, but instead proposed to provide permanent grounding of the power supply commons to the instrument ground. TED again stated that the SFAS was tested successfully with the commons grounded. The test results were reviewed by the SFAS vendor (Consolidated Controls Corporation), and found to be acceptable. TED stated that by installing the permanent grounds, that 1) the SFAS will meet the requirements of Section 4.6 of IEEE Std. 279 on channel separation criteria, 2) the possibility for a 118 Vac or 125 Vdc short to cause setpoint drift in associated (redundant) channels has been eliminated, and 3) continuous monitoring of the commons is not necessary (a fault condition similar to that prior to the December 5, 1980 actuation should cause the affected channel to fail in the tripped condition and alert the operators immediately).

It appears that permanent grounding of the shared floating commons may resolve the staff's concerns regarding SFAS channel independence. However, it should be noted that the Davis-Besse plant has had a history of problems regarding the instrument ground system and its relationship to the station ground system. The specific concern was that inadvertent ties exist between these systems at other than the designed common tie point. Given an electrical fault,

loop fault current could produce an induced voltage in systems connected to the instrument ground, potentially affecting system operability. TED stated in Reference 5 that no inadvertent ties had been identified between the SFAS instrument ground (i.e., the floating commons described above) and the station ground, so that electrical faults would not affect engineered safety features operability. Both References 2 and 5 indicate that the SFAS (and the SFRCS and steam generator level systems) were designed and shipped with separate instrument and station ground systems (only analog signal cable shields are connected to the instrument ground bus). TED committed in Reference 5 to continue to analyze and test the instrumentation systems at Davis-Besse to identify and eliminate any inadvertent connections between the instrument ground grid and the station ground grid so that the installation fully meets the design criteria. The results of this testing were provided by Reference 7. One inadvertent tie was identified in SFAS channel 4. The tie was located and removed. The staff's evaluation (Reference 6) of TED's analysis which demonstrated that safety systems will perform as intended given the worst case station electrical fault condition with the inadvertent ties present between the instrument and station ground systems, concluded that the installed instrument-station ground system is acceptable. This conclusion was partially

based on our understanding that there were no inadvertent ties between the SFAS instrument ground and the station ground, and therefore, that faults could not be postulated that would adversely affect the engineered safety features of the facility.

Given the past problems with circulating currents in the instrument-station ground system, the emphasis placed on maintaining the SFAS instrument ground separate from the station ground, and TED's previous reluctance to connect the SFAS instrument ground to the station ground (for reasons stated in Reference 2), the additional information requested in Enclosure 1 must be provided by TED before their proposed modification (connecting the SFAS instrument ground to the station ground) can be accepted by the staff. TED's response to the request for additional information should help the staff determine whether the proposed modification is an acceptable approach to resolving the SFAS channel separation concern, and whether operability of the SFAS will be assured following such a modification. Based on the licensee's response and the final corrective actions taken at Davis-Besse, the staff will pursue similar resolution for other operating reactors with a similar (Consolidated Controls Corporation) design.

References:

1. Letter dated August 12, 1981 from John F. Stolz (NRC) to Richard P. Crouse (Toledo Edison Company - TECo)

2. Letter dated September 15, 1981 from Richard P. Crouse (TECo) to John F. Stolz (NRC)

3. Letter dated January 31, 1983 from John F. Stolz (NRC) to Richard P. Crouse (TECo)

4. Letter dated March 11, 1983 from Richard P. Crouse (TECo) to John F. Stolz (NRC)

5. Letters dated August 30 and September 16, 1977 from Lowell E. Roe (TECo) to Domenic B. Vassallo (NRC)

6. Letter dated September 26, 1977 from Domenic B. Vassallo (NRC) to Lowell E. Roe (TECo)

7. Letter dated November 4, 1980 from Richard P. Crouse (TECo) to Robert W. Reid (NRC)