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U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555

South Texas Project
Units 1 and 2
Docket Nos. STN 50-498, STN 50-499
Additional Information Concerning Electrical
Cable Separation for the
Solid State Protection System

Reference: A. Wisenburg, M.R., HL&P; Responses to I&C Audit Items; Letter to NRC, dated March 13, 1987; ST-HL-AE-1943

B. Kadambi, N.P., NRC; Summary of Meetings and Audits on Electrical Instrumentation and Control Systems, Equipment Qualification, SPDS, and Control Room Design Review Subjects; Letter to HL&P, dated March 12, 1987; ST-AE-HL-91194

During the period of January 28-30, 1987, the NRC staff held audits in the areas of Instrumentation & Control (I&C) Systems, Electrical Systems, Control Room Design Review (CRDR), and the Safety Parameter Display System (SPDS) at the South Texas Project site. An exit meeting was held at the conclusion of each audit to summarize the concerns which had been identified.

Responses to most of the concerns identified during the I&C Audit were provided in Reference A. This letter provides a separate response to the concerns on electrical cable separation for the Solid State Protection System (SSPS). The items concerning SSPS as listed in both our initial response to the audit (Reference A) and in the detailed audit notes (Reference B) are addressed. Attachment 1 provides responses to the specific SSPS items listed in the NRC audit report (Reference B). Attachment 2 contains a discussion of the noise and fault testing performed on the SSPS, including background, applicability to the South Texas Project (STP), and a summary of the tests performed.

The information contained in Attachments 3 through 5 has been previously submitted on the Diablo Canyon docket and is provided for your information. Copies of correspondence between Pacific Gas & Electric Company (PG&E) and the

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NRC are provided in Attachment 3. Resolution of NRC concerns, based upon the additional testing performed, resulted in the Safety Evaluation Report contained in Attachment 4. Finally, Attachment 5 contains the Westinghouse Protection Systems Noise Test Report.

If you should have any questions on this matter, please contact Mr. M. E. Powell at (713) 993-1328.

M. R. Wisenburg
Manager, Engineering and Licensing

THC/yd

Attachments:
1. Responses to I&C Audit Items Concerning The SSPS
2. Summary of Westinghouse Solid State Protection Systems Noise and Fault Testing
3. Background Correspondence Concerning the Westinghouse Protection Systems Noise Tests
4. NRC Safety Evaluation of the Westinghouse Protection Systems Noise Test Report, dated April 22, 1976
5. Westinghouse Protection Systems Noise Test Report, Revision 2, October 1975

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*With all Attachments; All others with Attachments 1 and 2 only.

Attachment 1

Responses to I&C Audit Items Concerning The SSPS

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South Texas Project
Units 1 and 2
Docket Nos. STN 50-498, STN 50-499
Responses to I&C Audit Items
Concerning The Solid State Protection System

1. (NRC 2) For both trains (R and S), the applicant has not provided acceptable separation for the logic input wiring to the SSPS. By analysis the applicant has stated that 1" separation will be maintained between the sil-temped input cables. The cabling in both digital input enclosures should be routed so that this 1" separation is maintained. In addition the red logic input cable for train S should be siltemped as required by the South Texas separation criteria. The applicant should verify that these actions are completed.

Response:

This concern was previously addressed as item 6 of Reference A. As stated in Reference A, the SSPS cabinets are included in the walkdown program and cable separation will be verified to meet project criteria.

2. (NRC 1.a) Synchronization cables (503 and 504) that are routed between train R and train S do not meet the separation criteria specified in Westinghouse documentation. According to this documentation, these cables, orange and green, should meet the separation criteria specified in Section 8.3.1.4.4.5 of the South Texas FSAR. Furthermore, the cables should be identified according to Section 8.3.1.3 of the FSAR.

Response:

The SSPS synchronizing cables installed at the South Texas Project are routed between the SSPS cabinets in dedicated conduits with bottom entry to the SSPS logic cabinets. There are no external faults which can be imposed on these cables.

The conduits are terminated within the floor slab below the SSPS logic cabinets. The cables are routed up through the floor into the SSPS cabinets to the final termination. The floor opening has been filled with a penetration sealing material to form a fire stop. The South Texas Project elementary drawings stipulate that the train R and S time synchronizing cables should be separated from each other and other cabinet cables to an extent as reasonable as achievable. In some instances, the 6 inch separation criterion was not met due to physical constraints. Internal cabinet wiring does not provide 6 inch separation and, in fact, the connectors for these cables are not physically six inches apart. The use of dedicated conduits for these cables at STP meets the intent of this requirement.

As discussed in Attachment 2, the Westinghouse Protection Systems Noise Test Report contained in Attachment 5 is applicable to these cables based on the configuration of the equipment tested. In this configuration the faulted cables were tied to Class 1E cables for a distance of 20 feet; the results showed no fault propagation between cables. The time synchronizing cables therefore meet the separation requirements of FSAR Section 8.3.1.4.4.5, item 2C, which provides for analysis of specific situations. No additional separation of these cables is necessary.

These cables were identified in accordance with FSAR Section 8.3.1.3 at the time of installation. Some of the cable tags apparently slipped down the cables such that they were covered over when the fire stop material was poured into the floor penetration below the cabinet. Any cable tags which are not visible will be replaced.

3. (NRC 1.b) Non-Class 1E multiplexer cables in both train R and train S of the SSPS cabinets are bundled with the respective divisional cabling. This lack of separation continues as the non-safety and divisional cables exit the cabinets (top exit). After several feet, the non-Class 1E cabling enters a non-Class 1E tray and the divisional cabling enters safety-related conduits and trays. The licensee should (1) provide an analysis that justifies the lack of separation within the SSPS cabinets between the non-Class 1E multiplexer cables and the train R and Train S cabling, (2) reroute the non-1E cabling upon exiting the SSPS cabinets so that it meets the separation criteria stated in Section 8.3.1.4.4.5 of the FSAR, and (3) perform a tray analysis for the non-1E multiplexer cable and provide the voltage levels and current carrying capacity for the worst case fault cable routed in this tray.

Response:

The non-Class 1E Demultiplexer (DEMUX) cable is bundled with another cable within the SSPS cabinet prior to final termination. Investigation has indicated that the other cable in the bundle was the computer demultiplexer cable, which is also a non-Class 1E cable. The gray cable was found to be the "OR" cable running between the R and S SSPS logic cabinets, which is eventually routed to the main control board demultiplexer. As indicated above, all are non-Class 1E cables.

In addition, two Class 1E cables were bundled together in the vicinity of the bundled non-Class 1E cables. These Class 1E cables were identified to contain the reactor trip bistable signals enroute to the undervoltage coils in the switchgear. These two bundles of cables run in close proximity within the SSPS train R logic cabinet.

As discussed in Attachment 2, the Westinghouse Protection Systems Noise Test Report contained in Attachment 5 is directly applicable to these cables based on the configuration of the equipment tested. In the configuration tested, cables were tied together for a distance of 20 feet; results showed no fault propagation into the Class 1E cables. At STP, in no case, does the cable length where 6 inch cable separation is not provided outside the SSPS cabinets exceed 6 feet; generally, it does not exceed two feet.

A review of the cables routed in the instrumentation trays with the DEMUX cables verified that the highest voltage levels are 120 VAC and 125 VDC. The worst case fault current which could be generated by other cables in these trays is 1A at 120 VAC.

The DEMUX cables are themselves low energy cables. During normal operation, these multiconductor 24 gauge cables carry a few milliamps at 48 VDC. The worst case faults which could be generated within the SSPS and applied to these cables are 13A at 15 VDC and 7A at 48 VDC. As stated in Attachment 2, these cables passed a dielectric strength test at 1240 VAC. In addition, the isolation devices prevented propagation of faults well in excess of these levels.

Based on the information provided above, the DEMUX cables meet the separation criteria of FSAR Section 8.3.1.4.4.5, item 2C, which provides for analysis of specific situations. No additional separation of these cables is necessary.

4. (NRC 4) During its review of the SSPS enclosures, the staff noted several instances where Group NM (black) cabling was separated by less than 6" from Divisional train R (orange) and S (green) cabling. In several instances the black cabling was actually bundled (touching) with the orange and green cabling. The applicant should provide the analysis that allows this less than 6" separation and, in some areas, the less than 1" separation. If this cannot be provided, then the applicant should implement separation criteria according to Section 8.3.1.4.4.5 of the FSAR.

Response:

This is the same concern as identified in item 3 above. Non-Class 1E Computer and Control Board DEMUX cables enter both logic train R and logic train S SSPS cabinets in close proximity to Class 1E cables. Based on the discussion provided in response to item 3, no additional separation is necessary.

Attachment 2

Summary of Westinghouse Solid State Protection Systems
Noise and Fault Testing

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Summary of Westinghouse Solid State Protection Systems Noise and Fault Testing

BACKGROUND

At a generic meeting with NRC EICSB personnel in August 1974, considerable discussion occurred concerning wiring separation within the I&C protection racks. It was at that meeting that Westinghouse agreed to perform additional tests to demonstrate that credible electrical faults and/or noise induced in control cables external to the racks could not degrade protection system performance. In support of the Diablo Canyon application, Westinghouse agreed to submit a generic report on the tests and test results for technical review. A brief discussion of the tests conducted is presented later in this attachment.

On January 16, 1975, Pacific Gas and Electric Company (PG&E) submitted to the NRC on the Diablo Canyon docket, a report entitled "Westinghouse Protection Systems Noise Tests" dated December 1974. The test report was divided into three sections covering the following Westinghouse supplied systems: Section A - Solid State Protection System (SSPS); Section B - Nuclear Instrumentation System; and Section C - Process Analog System 7100 Series.

During a subsequent meeting with the NRC in February 1975, NRC electrical reviewers expressed concern on the effect of 460 VAC faults on the control side of the isolation devices in the as-built Process Analog System 7100 Series. Fault tests utilizing a 460 VAC potential were subsequently conducted with results submitted to the NRC in April 1975 as Revision 1 to the December 1974 report.

In September 1975, the NRC issued the results of their review on the Westinghouse Protection Systems Noise Tests report of December 1974 and the supplementary information submitted in April 1975. A brief summary of the regulatory review is given below:

> "The test program was conducted as a result of our concerns relating to the lack of physical separation between the protection and control circuits in the final implementation of the system designs which could result in interaction between control and safety functions." The staff concluded "the tests and results as documented in the report are acceptable for the Solid State Protection System, the Nuclear Instrumentation System...with the exception of the noise susceptibility tests." The staff required that the acceptance criteria be changed to indicate that noise which causes spurious initiation of a protection action or function will be identified. If the spurious trips or initiation of protective actions occur due to lack of separation, they will require a design change to provide adequate separation to eliminate the spurious operations. The staff

also required that a modified Noise Susceptibility Test Program be initiated for the Process Analog System 7100 Series. In particular, the noise source output cable shall run in the same cableways as the input/output cables of the 7100 Series system for this test".

Additional tests were conducted to address the NRC concerns raised in the September 1975 evaluation report. The original test report (December 1974) was modified to reflect the revised acceptance criteria and the results of the additional tests. These changes were submitted to the NRC in November 1975 as Revision 2 of the initial test report as amended by Revision 1.

In April 1976, the NRC completed their evaluation of the report entitled "Westinghouse Protection Systems Noise Tests" dated December 1974 as amended by Revisions 1 and 2. The staff issued the following regulatory position:

"We have concluded that the test program, as documented through Supplement 3, is acceptable. The results of the test program indicate that the systems are not degraded below an acceptable level and can perform their safety functions, during the faulted conditions tested, as implemented at the Diablo Canyon Nuclear Power Station.

We require that any applicant referencing this report provide justification that the tests reported encompass the potential electrical faults or interference reflecting into the systems tested as a result of their particular balance-of-plant designs."

In summary, the Westinghouse-supplied Solid State Protection System, Nuclear Instrumentation System and Process Analog System 7100 Series were subjected to a rigorous series of noise and fault voltage tests to (a) demonstrate that the introduction of those signals would not degrade the ability of the protection systems to provide the necessary action and (b) identify any spurious initiation of protective functions that were a result of those signals.

The results of the testing showed conclusively that electrical interference or noise is not a consideration or concern in the proper operation and functioning of the Solid State Protection System. In all tests, the system produced reactor trip and safeguards actuation as required. No maloperation of the display of system status to the computer and control board through the multiplexing subsystem was observed in any of the tests.

APPLICABILITY TO THE SOUTH TEXAS PROJECT

As stated in the NRC staff evaluation, dated April 1976, on the "Westinghouse Protection Systems Noise Test" report, "other applicants referencing the report will need to provide justification that the tests reported encompass the potential electrical faults or interference reflecting into the systems tested as a result of the particular plant's design."

The South Texas Project has confirmed that the highest voltage associated with any of the cables routed with the demultiplexer and "OR" cables does not exceed the maximum credible faults referenced in the test report.

Furthermore, the electrical interference induced or introduced into the control cabling in the test report encompassed that reasonably assumed because of control cable routing outside the cabinets at South Texas.

Even though the intent of the December 1974 test report was only to justify the exception to Regulatory Guide 1.75 separation criteria within the three instrumentation systems tested, the test results may be applied to the lack of physical separation between Class 1E and isolated non-Class 1E cabling for a short distance immediately outside the Westinghouse SSPS cabinets. This extension of applicability is based upon the actual test configuration, where the faulted cables were bundled with non-faulted cables over a span of approximately 20 feet. In the case of the South Texas Project, this short distance should be construed as the distance from point of cable exit from the cabinet to the point at which it enters a cable tray or dedicated conduit. In no situation associated with the SSPS does this distance exceed 6 feet. This allowance is necessary to facilitate the routing of field cables to and within the SSPS cabinets. The tests conducted demonstrated the adequacy of the system isolation devices for credible fault voltages or noise faults imposed on the output (non-Class 1E) cabling without regard to whether the signals were applied inside or immediately outside the cabinet. The tests showed that the lack of separation of Class 1E and non-Class 1E cabling does not provide for voltage or noise "crosstalk" into the protection circuits to degrade performance if the postulated faults are limited to those considered in the test report.

The tests for the December 1974 noise report were conducted assuming that the synchronizing cables were separated from each other and other cabinet cables to the maximum reasonable extent.

No flexible conduit or special wrapping was applied to these cables for the test configuration. Although faults were not specifically applied to the time synchronizing cables during testing, the test results are applicable to these cables since the isolation devices and cable dielectric strength specifications are identical to those for the DEMUX cables.

Based on the test results obtained, it is not necessary to provide additional separation, install a protective wrap, or install flexible conduit for protection of Class 1E cables from faults introduced into the DEMUX cables or to protect one logic train from faults introduced through the time synchronization cable from the opposite logic train. The effort and expense involved with installing and maintaining a fire retardant wrap over the life of the plant is unwarranted. During all tests, the SSPS produced reactor trip and ESF actuation as required. No maloperation of the display of system status through the demultiplexers was observed during any of the tests.

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Test Summary

Section A paragraph C of the Westinghouse Protection System Noise Tests provides a description of the noise susceptibility tests that were conducted in accordance with MIL-N-19900B. The tests were run with a 20 ft antenna in contact with the SSPS demultiplexer and "OR" cables. Two noise sources were utilized in the test. For conservatism, the non-Class 1E cable shields were lifted from ground at both ends. In addition, the input (Class 1E) and output (non-Class 1E) cable harnesses at the isolator were forced into contact and bound together to remove all physical separation.

Additional noise tests were run with the maximum credible fault voltages connected to the cabinet output (non-Class 1E) wiring of one isolator (118 VAC and 250 VDC).

Finally, a noise test was run to determine the effect of magnetic pickup on isolator input (Class 1E) wiring resulting from current flow in isolator output (non-Class 1E) wiring. A current of one ampere AC was run through the cabinet isolator output wiring.

In addition, all time synchronizing, demultiplexer, and "OR" cable assemblies passed a dielectric strength test at 1240 VAC RMS from the connector shells to all connector pins and from the drain wire pin to all other pins.

The acceptance criterion established was that the noise tests described above would not interfere with the proper operation of the SSPS.

The results of the testing conclusively indicated that electrical interference or noise is not a consideration or concern in the proper operation and functioning of the Solid State Protection System. The tests also showed that the lack of physical separation between Class 1E and non-Class 1E cabling does not result in "crosstalk" into the protection circuits. During all tests, the system produced reactor trip and safeguards actuation as required. No maloperation of the display of the system status to the computer and control board through the multiplexing subsystem was observed during any of the tests.

In addition to the SSPS system-level tests described above, tests were conducted on the devices used to isolate the SSPS train cables from the computer and control board demultiplexer cables and from each other. The objective was to confirm design requirements that credible electrical faults in interconnections between trains and demultiplexers be isolated from the protection system.

Common mode dynamic and impulse potentials were applied as follows:

a) 2 KV DC dynamic

b) 140 V RMS 60 Hertz dynamic

c) Impulse tests at 2 KV peak, 1 MHZ ringing down in 6-10 cycles applied for 1 minute.

The tests showed that potentials applied on the output (non-Class 1E) side of the isolation device did not directly (flashover) or indirectly (induced or capacitance coupled) propagate into the train protection logic. Additionally, a destructive test of the isolation device confirmed that the input side of the isolation device did not see the destruct voltage through distributed capacitance.

Attachment 3

Background Correspondence Concerning the
Westinghouse Protection Systems Noise Tests

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Background Correspondence Concerning the
Westinghouse Protection Systems Noise Tests

Copies of the correspondence listed below are enclosed for your information and use in reviewing the background of the Westinghouse Protection Systems Noise Tests:

1.	Report on W Protection Systems Noise Tests	January 3, 1975
2.	Submittal of W Protection Systems Noise Tests to NRC	January 16, 1975
3.	Supplement to W Protection Systems Noise Tests	February 28, 1975
4.	Submittal of supplementary pages for the Noise Report to the NRC (Rev. 1)	April 7, 1975
5.	W letter on 7300 fault testing to NRC	August 19, 1975
6.	NRC comments on W Noise Test Report	September 4, 1975
7.	Letter from NRC to W on 7100 Process Control Systems	October 14, 1975
8.	Amendment to W Protection Systems Noise Test	November 14, 1975
9.	Submittal of W Protection Systems Noise Tests (Rev. 2) to the NRC	November 24, 1975

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Attachment 4

NRC Safety Evaluation of the
Westinghouse Protection Systems Noise Tests

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Attachment 5

Westinghouse Protection Systems
Noise Test Report, Revision 2, October 1975

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Westinghouse Electric Corporation Power Systems

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Pittsburgh Pennsylvania 15230

January 3, 1975

PGE-2893

S.O. PGE-320, 330, 385

Ref: W Letter PGE-2816
Dated 9/20/74

893 - 320 - 000
330
385

Mr. D. V. Kelly
Chief Mechanical Engineer
PACIFIC GAS AND ELECTRIC COMPANY
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Attention: Mr. J. Hoch

PACIFIC GAS AND ELECTRIC COMPANY
NUCLEAR PLANT, DIABLO CANYON SITE
UNITS NUMBER 1 AND 2
Report on W Protection
Systems Noise Tests

Enclosed are 35 copies of the technical report, "W Protection Systems Noise Tests". As discussed with your Mr. J. Hoch on January 2?, 1975, these reports are for your use to forward to NRC for placement in the Public Document Room and amend the Diablo Canyon FSAR to reference the report.

Submittal of this report was agreed to by NRC and Westinghouse. Reactor Protection Evaluation and Engineering believe that these tests confirm the adequacy of electrical cable separation within Westinghouse Protection System cabinets and it is intended that this report will be the basis for a Westinghouse Topical Report.

The Noise Tests Report is non-proprietary. Included is general information concerning the purpose and scope of the test program and technical procedures and results. Also included in Appendix A of Test Section A covering the Solid State Protection System are verification test results on the Isolation Board (LED) used in this system.

Please advise if you have any further questions.

Very truly yours,

WESTINGHOUSE ELECTRIC CORPORATION

P. Blau

P. Blau
Project Engineer

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Enclosures 35

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