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SUBJECT: Part 21 rept re multiple CEA slip/drop events.

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COMBUSTION ENGINEERING

April 20, 1989
LD-89-045

Dr. Thomas E. Murley, Director
Office of Nuclear Reactor Regulation
Attention: Document Control Desk
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Subject: Multiple CEA Slip/Drop Events

Dear Dr. Murley:

This letter confirms my April 19, 1989, 10CFR21 verbal notification to Mr. J. G. Partlow (NRC) reporting a potential safety concern related to multiple Control Element Assembly (CEA) slip or drop events.

Combustion Engineering's investigation of the multiple CEA slip event that occurred at Palo Verde 1 on December 10, 1988, has identified that a single fault, intermittent grounding of a Control Element Drive Mechanism (CEDM) coil lead during CEA stepping, may result in a multiple CEA slip or drop. This unanticipated consequence, which is outside of the plant design basis, may occur due to intermittent ground fault noise induced into CEDM control system circuits. At Palo Verde 1, the suspected fault is a break in the insulation of the CEDM lower lift coil lead, which permitted intermittent arcing between the coil lead and an adjacent nipple assembly during CEA stepping. Such intermittent arcing may result in a slip or drop of other CEAs. A ground fault indication from the CEDM Motor Generator set, therefore, may be indicative of an increased risk for a multiple CEA slip or drop event.

It is our understanding that all Palo Verde units affected lower lift coil stack assemblies have been or will be replaced prior to plant startup. It is also our understanding that a procedure has been implemented at Palo Verde 1, 2, and 3 requiring a prompt reactor trip upon detection of an event where two or more CEAs slip or drop. These are prudent actions that should prevent exceeding the plant safety limits even in the unlikely event of a multiple CEA slip or drop. The Enclosure summarizes the information available to us at this time.

IE19 Add: T. E. Murley  Ltr Encl

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The potential safety concern identified is applicable to WNP-3 in addition to the Palo Verde units. Other units with similar CEDM control systems include Arkansas 2, San Onofre 2, 3, Waterford 3, and St. Lucie 2. Because of differences in CEDM control system designs, Maine Yankee, Millstone 2, Calvert Cliffs 1, 2, and St. Lucie 1 are less likely to experience similar problems. Further, Palisades and Fort Calhoun are believed unlikely to be affected since they have substantially different CEDM designs.

If you have any questions on the above, please feel free to contact me or Dr. J. M. Betancourt of my staff at (203) 285-4125.

Very truly yours,

COMBUSTION ENGINEERING, INC.

A. E. Scherer
Director
Nuclear Licensing

AES:jeb

Enclosure: As Stated

cc: Dr. S. T. Brewer (C-E)

(i) **Name and address of the individual or individuals informing the Commission.**

Combustion Engineering, Inc.
1000 Prospect Hill Road
Windsor, CT 06095

(ii) **Identification of the facility, the activity, or the basic component supplied for such facility or such activity within the United States which fails to comply or contains a defect.**

Investigation of the multiple CEA slip event at Palo Verde 1 on December 10, 1988, has identified that a single fault, intermittent grounding of a CEDM wire coil lead during CEA stepping, may result in a multiple CEA slip. This unanticipated consequence, which is outside of the plant design basis, may occur due to the intermittent ground fault noise induced into specific CEDM control system zero crossing detector circuits.

(iii) **Identification of the firm constructing the facility or supplying the basic component which fails to comply or contains a defect.**

Combustion Engineering, Inc.
1000 Prospect Hill Road
Windsor, CT 06095

(iv) **Nature of the defect or failure to comply and the safety hazard which is created or could be created by such defect or failure to comply.**

The possibility that a single Control Element Assembly (CEA) may become displaced relative to other CEAs within its group is a design basis event for C-E NSSSs. Multiple single CEA slips or drops are outside of the design basis.

On December 10, 1988, two CEAs from different control groups slipped at Palo Verde 1 while performing surveillance testing at 80 percent power. For this specific CEA deviation, C-E determined that adequate margin to the safety limits existed during the course of the event. Other combinations of slipped or dropped CEAs, however, could potentially exceed the safety limits as defined in the technical specifications of the license for operation issued pursuant to 10CFR50.

As part of the continuing investigation of the root cause of the slippage at Palo Verde 1, intermittent grounding of a CEDM coil lead wire has been postulated as being able to cause a multiple CEA slip. Intermittent grounding has been exhibited occasionally during CEDM operations at Palo Verde 1 and 2 since the beginning of plant operation. Examination of two lower lift coils removed from two CEDMs at Palo Verde 2 have confirmed the grounding indications. These two lower lift coils, although previously exhibited grounding indications, did not result in a double

slippage. Disassembly of the two lower lift coil assemblies revealed failed insulation on the coil lead wires and evidence of arcing to the nipple assembly. As a result, it is expected that removal and disassembly of the two Palo Verde 1 suspect CEDM coil stacks will reveal similar failed insulation and arcing on the lower lift coils.

The multiple CEA slips may occur due to noise induced from the intermittent single grounding fault into specific CEDM control system circuitry. The scenario is believed to have been as follows:

(1) The missing lower lift coil lead wire insulation has probably existed since initial operation. This condition is not expected to develop as a result of normal operation or aging.

(2) The lower lift coil motion during stepping enabled an intermittent electrical arc between the energized lower lift coil and ground. The magnitude of the arcing appears to have increased with time, due to repeated stepping.

(3) The arc introduced a higher level of noise into the CEDM control system.

(4) The higher noise eventually interfered with the zero crossing detector circuit in the CEDM control system, reducing the voltage holding another CEA and, therefore, caused another CEA to slip.

The lower lift coils are unique to the Palo Verde and WNP-3 plants.

(v) **The date on which the information of such defect or failure to comply was obtained.**

Initial C-E determination - April 18, 1989.

(vi) **In the case of a basic component which contains a defect or fails to comply, the number and location of all such components in use at, supplied for, or being supplied for one or more facilities or activities subject to the regulations in this part.**

The identified defect is applicable to Palo Verde 1, 2, and 3 and WNP 3. The CEDM system for these plants is unique in that no other C-E plants have the lower lift coil. That is, these plants have the only drive mechanism with four-coil stacks. No other coils in these units have exhibited the grounding phenomena. Additionally, the lower lift coil lead wires can move during CEA exercising which enables the intermittent grounding identified to occur.

St. Lucie 2, Arkansas Nuclear One 2, Waterford 3, and San Onofre 2 and 3 do not have the lower lift coil and their operational history does not support similar fault occurrences. They do, however, have the zero crossing detector circuit in the CEDM

control system. Similar intermittent ground faults of an unknown source, therefore, may be possible for these plants and similar consequences may result.

The CEDM control system design supplied by C-E for Maine Yankee, Millstone 2, St. Lucie 1, and Calvert Cliffs 1 and 2 are different and the likelihood of similar multiple CEA slips or drops are substantially reduced.

Palisades and Ft. Calhoun have significantly different control drive mechanism designs and should not be susceptible to similar multiple CEA slips or drops.

(vii) **The corrective action which has been, is being, or will be taken; the name of the individual or organization responsible for the action; and the length of time that has been or will be taken to complete the action.**

It is our understanding that all Palo Verde 1 and 2 affected lower lift coil stack assemblies have been or will be replaced prior to plant startup. It is also our understanding that a procedure has been implemented at Palo Verde 1, 2, and 3 requiring a prompt reactor trip upon detection of an event where two or more CEAs slip or drop.

The licensee for WNP-3 is being notified by C-E of the events and concerns regarding the Palo Verde units and the CEDM and CEDM control system design.

C-E also issued an Infobulletin on March 17, 1989, (attached) alerting all C-E NSSS plant licensees of the Palo Verde 1 event. The recommendation of the Infobulletin was for all utilities to evaluate the completeness of existing plant procedures and technical specifications to address multiple CEA deviations.

(viii) **Any advise related to the defect or failure to comply about the facility, activity, or basic component that has been, is being, or will be given to purchasers or licensees.**

C-E issued a supplemental Infobulletin on the subject of multiple CEA slip/drop events on April 19, 1989 (attached). A recommendation of this Infobulletin is that utilities repair or replace CEDM coils that exhibit grounding and instruct operators to be alert to future grounding indications. Additionally, utilities should consider an evaluation of the existing CEA control system to confirm whether it could produce multiple CEA slip or drop events. Should a multiple CEA slip or drop be detected, utilities should ensure that prompt actions will be implemented, for example, a plant trip or if justified a power reduction, to prevent exceeding plant safety limits.

No. 89-02

March 17, 1989

# Multiple CEA Drop/Slip Events

Introduction: The possibility that a single Control Element Assembly (CEA) may become displaced relative to other CEAs within its group is a design basis event for C-E NSSSs. Multiple CEA slips or drops are outside of the design bases. This Infobulletin is based on an event at Palo Verde-1 on December 10, 1988, where two CEAs from different control groups slipped while performing surveillance testing at 80% power with the Control Element Assembly Calculators (CEAC) out of service.

Discussion: A single CEA drop event in a C-E NSSS plant with a digital reactor protection system is categorized as an Anticipated Operational Occurrence (AOO) which is analyzed to assure that the Specified Acceptable Fuel Design Limits (SAFDL) of peak linear heat rate and DNBR are not exceeded. The design basis of the CEA control system is that, when operated within the design, interface and maintenance requirements, a single malfunction of the CEA control system should not cause multiple CEAs to slip or drop. Multiple CEA slips or drops are not expected to occur with sufficient frequency to be classified as an AOO.

C-E NSSS plants with an analog reactor protection system do not provide an automatic reactor trip to protect against multiple CEA deviations; plant procedures require operator actions to terminate an event of this type. C-E NSSS plants with a digital reactor protection system incorporate dual CEACs to monitor CEA position. The CEACs generate penalty factors based on the deviation between CEAs in a subgroup. The penalty factors are input to the Core Protection Calculator (CPC) and may result in a reactor trip signal being generated if CEA deviations exceed preset limits. Multiple CEA deviations are not considered in the design basis; therefore, the reactor may not trip automatically for certain adverse configurations of multiple CEA deviations.

The CPC/CEAC system at Palo Verde-1 is designed to preclude exceeding the SAFDL should a CEA become mispositioned relative to its group while operating within the limiting conditions for operation. However, multiple CEA slips or drops are not within the design basis and the existing technical specifications and safety analyses do not assure that the SAFDL conditions would not be exceeded should such an event occur.

For the specific CEA deviations that occurred at Palo Verde-1 on December 10, 1988, C-E has determined that adequate margin to the SAFDLs existed during the course of the event. However, it is C-E's opinion that other combinations of slipped or dropped CEAs from the 80% power conditions used

during CEA surveillance testing at Palo Verde-1 could potentially exceed the SAFDLs even if an operator-initiated power reduction was implemented.

C-E advised Arizona Public Service Co. that, as an interim measure in the absence of detailed analyses, a prompt reactor trip (within 20 seconds) would assure that SAFDLs would not be exceeded if two or more CEAs were to slip or drop at Palo Verde-1 during CEA testing at 80% power. C-E also advised APS to perform CEA testing only with both CEACs operable so that some multiple CEA slips or drops would result in an automatic reactor trip.

An investigation of the cause of the slippage at Palo Verde-1 is continuing. Also, Arizona Public Service and C-E are developing a plan to quantify risks associated with a double CEA slip or drop event at Palo Verde. This effort will assess the consequences of dropping two CEAs and provide guidance for operator actions following such an event.

Recommendation: Utilities are advised to evaluate the completeness of existing plant procedures and technical specifications to address multiple CEA deviations.

Applicability: All C-E NSSS plants.

Contact: Joaquin Betancourt (C-E) 203/285-4125

No. 89-02/S01

April 19, 1989

# MULTIPLE CEA SLIP/DROP EVENTS

Introduction: C-E Infobulletin 89-02, dated March 17, 1989, discussed multiple CEA slip/drop events. This Supplement provides additional information which has resulted from the continuing investigations at Palo Verde. C-E will file a report pursuant to 10CFR21 to notify the NRC of these findings.

Discussion: Investigation of the multiple CEA slip event at Palo Verde-1 has identified that a single fault, intermittent grounding of a CEDM coil lead during CEA stepping, may result in a multiple CEA slip or drop. This unanticipated consequence, which is outside of the plant design basis, may occur due to intermittent ground fault noise induced into CEDM control system circuits. At Palo Verde-1, the suspected fault is a break in the insulation of the CEDM lower lift coil lead, which permitted intermittent arcing between the coil lead and an adjacent nipple assembly during CEA stepping. Such intermittent arcing may result in a slip or drop of other CEAs. A ground fault indication from the CEDM motor generator (MG) set, therefore, may be indicative of an increased risk for a multiple CEA slip or drop event.

Two CEDM coils at Palo Verde-2 had exhibited similar MG set grounding but had not resulted in a CEA slip. Disassembly of these two CEDM coil stacks revealed a break in the lower lift coil lead wire insulation and evidence of electrical arcing to an adjacent nipple assembly. No further indication of intermittent grounding has occurred at Palo Verde-2 since these two lower lift coils were replaced. It is expected that disassembly of the two suspect CEDM lower lift coil stacks from Palo Verde-1 will reveal similar insulation and arcing problems. Evidence suggests that this grounding phenomenon, identified only in two CEDM lower lift coils at Palo Verde-2 and suspected on two coils at Palo Verde-1, has existed since the beginning of plant operation. However, the only multiple CEA operational fault reported from Palo Verde-1 occurred after approximately three (3) years of plant operation. It was noted during testing at C-E that the CEDM lower lift coil leads can move slightly during CEA operation. This movement in conjunction with a break in the coil lead insulation caused the intermittent ground fault to occur on these coils. Movement of the lower lift coil is a phenomenon that may be unique to the System-80 design plants. The fault mechanism postulated at Palo Verde is believed unique to the 4-coil stack CEDM design utilized for System-80 plants. However, intermittent ground faults from an unknown source may introduce like effects in other plants equipped with similar CEDM control systems.

Recommendation: C-E believes that the CEDM coil intermittent grounding phenomenon, unless exhibited during initial operation, is not expected to develop as a result of normal operation or aging. Monitoring for the existence of ground faults during CEA stepping is recommended. Utilities are advised to repair or replace CEDM coils that exhibit grounding.

Differences in CEA control system designs among the C-E NSSS classes may result in some plants being more susceptible to a multiple CEA slip or drop event. An evaluation of the existing CEA control system to confirm whether induced noise could result in a multiple CEA slip or drop event should be considered. Should a multiple CEA slip or drop be detected, utilities should ensure that prompt actions will be implemented, for example, a plant trip or if justified a power reduction, to prevent exceeding plant safety limits.

Applicability: This Infobulletin is applicable to Palo Verde and WNP-3. Other units with similar CEDM control systems include Arkansas-2, San Onofre-2,3, Waterford-3, and St. Lucie-2.

Because of differences in CEDM control system designs, Maine Yankee, Millstone-2, Calvert Cliffs-1,2, and St. Lucie-1 are less likely to experience similar problems. Further, Palisades and Fort Calhoun are believed unlikely to be affected since they have substantially different control element drive system designs.

Contact: Joaquin Betancourt (203) 285-4125