Westinghouse Electric Corporation
Energy Systems

Nuclear and Advanced Technology Division

Box 355
Pittsburgh Pennsylvania 15230-0355

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U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555

ATTENTION: Satish K. Aggarwal, Program Manager
Electrical & Mechanical Engineering Branch

SUBJECT: Westinghouse Comments Regarding Draft NUREG/CR-5555, "Aging Assessment of the Westinghouse PWR Control Rod Drive System"

At your request, Westinghouse has reviewed the final draft of NUREG/CR-5555, "Aging Assessment of the Westinghouse PWR Control Rod Drive System." Our comments are provided in the attachment to this letter.

If we can be of further assistance, please do not hesitate to contact us.

Very truly yours,

W. J. Johnson, Manager
Nuclear Safety Department

cc: K. Holzle, Esq., Office of the General Counsel
V. Wilson, Office of Nuclear Reactor Regulation

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WESTINGHOUSE COMMENTS REGARDING DRAFT NUREG/CR-5555

"AGING ASSESSMENT OF THE WESTINGHOUSE PWR CONTROL ROD DRIVE SYSTEM"

SUMMARY

Westinghouse recognizes the importance of the control rod drive system with regard to normal plant operation, as well as for reactor shutdown. The draft report prepared by BNL has been extensively reviewed by Westinghouse; our comments are provided herein.

For a report on aging effects to be useful and effective, it is necessary that the treatment of the data be based on aging-related failures and aging trends. A statistical analysis of the data to determine failure rates is not presented. This makes trending very difficult, and casts uncertainty on the conclusions presented in the report. Further, recognizing that the determination of whether a failure is age-related can be a difficult task, the approach taken with this report does not appear to be consistently applied.

The incidence of dropped control rods causing reactor trips as a result of failures in the CRD system is presented as a significant impact to plant safety systems. Westinghouse has demonstrated, with NRC agreement, that occurrence of a negative flux rate of limited magnitude does not require a reactor trip. Plants are currently in the process of updating their protection systems which will eliminate the initiation of a trip from a single or multiple dropped rod. Thus, future trip rates will be reduced.

Technical comments are provided relating to specific physical design features, performance requirements, and interpretation of failure events.

Detailed comments on the draft report are provided in the following pages.

GENERAL

In its present draft form, the generalized statements about the rod control system and its maintenance by operators are not felt to be supported by the analysis described; they convey no information that is not already recognized by industry programs. The conclusions should reflect specific evidence based on aging trends and aging-related failures, either explicitly derived by BNL or based on the literature. Likewise, numerous technical deficiencies in the report should be corrected before publication.

1. The stated purpose of the Nuclear Plant Aging Research (NPAR) program is to provide a technical basis for assessing aging effects on nuclear plant safety. On p. 1-5 it is stated as a specific objective to review operating experience to identify the dominant failure modes and mechanisms for CRDS components.

   Neither statistical nor detailed engineering analysis of failure modes and mechanisms is presented in the report. The statistical results presented consists of: 1) the percentages of CRDS failures by components (Figure 4-1); 2) failure counts implied in the FMEA, where failure types are categorized as having high, medium, or low frequencies; and, 3) a classification of 27 circuit board failures (Table 4-2).

   Since the counts were not divided by operating (or calendar) years, no failure rates were calculated; thus, no statistical evidence of aging trends is possible. The database of CRDS events developed in the BNL work is omitted, so verification of the event classification is not possible.

   Failure events are presumed to be age-related or otherwise based on the event narrative. If wear is noted in the report, for example, the event is classified as age-related. Because of its subjective nature, this approach is not fully adequate to either the NPAR program purpose or to aging management activities. It is tempting, but often incorrect, to classify all failures due to a process such as mechanical wear as age-related failures. As an example, an inappropriate design or misoperation may cause premature wearout, a risk which is not attributable to, or measured by length of service. (If subsequent operation implies that the problem was addressed, the poor early experience is no longer relevant). Where components are replaced periodically, or upon observation of degradation, the average risk over time is decreased; here, individual component age, and not plant age, is the appropriate measure of service exposure.

No trends are presented to show that the fraction of failures classified as aging-related actually increases with time. Such a test is virtually required to show that the subjective aging classification process is valid. In INEL work (NUREG/CR-4747, Vol. 1. p. 17-18) this test was made by counting reactor protection system events according to plant age (used as an upper bound on component age). The "aging fraction" assigned by INEL, apparently using the same method as the BNL study, actually decreased with age for switches, controllers, computation modules, power supplies and transmitters. The LER data presented in Appendix B of the present report likewise appear to show an improving trend: 7 of the 12 board failures occurred in the first two years. The same is true for 5 of the 9 power supply failures, 3 of the 5 discrete component failures, and 2 of the 5 connector failures. (If events in the first six months of service had not been arbitrarily excluded by BNL, the fraction of early failures would increase).

As a more definitive test, one can take the plant ages at failure as a proxy for board age for the circuit board failures, supplement these with the censored operating times for plants reporting no failure, and perform a Weibull analysis. The result confirms an improving trend with time for board failures, not a deteriorating one.

Westinghouse has shown to the satisfaction of the NRC that occurrence of a negative flux rate resulting from one or more dropped rods of limited magnitude does not require a trip. Therefore, as plants update their protection systems, no single or multiple dropped rod will initiate a trip. (The heat transfer margin available in the core accommodates the slight power increase in certain assemblies as a result of the flux redistribution). Negative flux rate trips in the past are thus not relevant to future trip rates as plants incorporate deletion of the negative flux rate trip. Consistent with this fact and the definition given for "High safety impact", events 1, 2, 3, 4, 6, 7, 8, 9, 10, and 11 in Table 5-1 should be described as "Low" safety impact.

3. The RCCAs are designed with component parts that are replaceable when necessary. Therefore, the inclusion of the RCCAs in this category of aging plant parts that are intended to last the lifetime of the plant is inappropriate.

4. Throughout the report the term "guide tube" is applied interchangeably to the Upper Internals guide tube, the CRDM guide tube, and the Fuel Assembly thimble tube. The report should be specific as to which guide tube is being discussed in each case. Additionally, it should be verified that the analysis of the data which has been performed is correct with respect to proper differentiation between the three types of "guide tubes."

5. The report addresses factors that are detrimental to components of the Rod Control system Power, Logic, DC Hold, and P/A Converter Cabinets. The 1960-technology-based components such as transistors are sensitive to temperature; performance at high temperature is derated per information published by transistor manufacturers. Based on this general knowledge, Westinghouse has advised users of the Rod Control System that the best ambient temperature for the system is 25 degrees Centigrade (the recommended temperature for optimum transistor performance). Westinghouse advises its users to perform periodic maintenance on components such as gripper fuses and connectors.

   The preferred approach to maintenance of the circuit board, exemplified by the maintenance program offered by Westinghouse to utilities, is to test every circuit board to original factory specifications. The purpose of the maintenance service, the failure detection circuits, and recommended maintenance by plant personnel is to identify components that are out of original specification and replace them before they cause a plant trip.

   In its microprocessor-based rod control system, Westinghouse uses state-of-the-art technology to expand the failure detection circuitry for better diagnostics. These functions address degradation and its impact on system availability and increase system availability through automatic transfer to redundant circuits. Westinghouse is also evaluating an On-Line Diagnostics Upgrade for the Solid State Rod Control system to expand the failure detection circuitry and to expand diagnostic capability.

Westinghouse and the rest of the industry are aware of the "aging" areas cited in the BNL report and are addressing the issue with recommendations for maintenance, development of replacements for obsolete components, and designing new systems with state-of-the-art components.

Specific comments on the various sections of the draft report are provided, organized by report section.

ABSTRACT

P. iii Draft Report: the Westinghouse CRD system is "subject to aging degradation which could affect its intended safety function as a plant ages".

Comment: No quantitative evidence is presented that the reliability of the Westinghouse CRDS has decreased with time. In some of the cited references, particularly a Westinghouse paper (Ref. 15), certain components have been shown to show wearout trends, while others show improving or nearly constant trends. Preventive maintenance practices address these equipment trends as they are manifested; this is the message of the utility responses to the BNL questionnaire.

P. iii Draft Report: "the number of trips due to CRDS failures warrants increased regulatory attention".

Comment: This finding ignores the outstanding success of industry programs in trip reduction. The trip rate in Westinghouse plants has declined sharply as a result of these efforts. The industry's attention to plant trip reduction and their success to date certainly merit reconsideration of the report's position on regulatory intervention.

P. iii Draft Report: a variation in plant-to-plant maintenance practices "possibly reflecting inadequacies at some plants".

Comment: That there are differences in maintenance practice is not evidence that some plants have inadequate maintenance. All plants follow test plans approved by the NRC to ensure CRDS reliability.

REPORT SUMMARY

P. v Draft Report: "the majority of failures are electrical."

Comment: The intent of stating this is unclear. (Presumably, it is due to the greater number of electrical components).

P. v Draft Report: "40% of events involve rod drop."

Comment: Again the finding does not specifically relate to aging. Moreover, the number of trips is decreasing with time.

P. v Draft Report: "more than one plant has seen cabinet overtemperatures and rod position drift."

Comment: This is only potentially relevant to aging because the components involved are periodically tested and, if degraded, are replaced. In the absence of demonstrated reduction in safety, this indicates no need for "generic resolutions".

P. vi Draft Report: "The normal operating and environmental stresses experienced by the system components have been assessed in order to determine their effect on long term system performance."

Comment: The assessment of operating experience was limited to counting events in which mechanisms such as fatigue, thermal aging, etc. were cited by the report initiator. To objectively define whether aging is occurring, time-dependent failure rates must be developed.

SECTION 2

P. 2-5 Draft Report: First paragraph, third sentence.

Comment: The length of this continuous portion varies between approximately 22.25 and 40 inches above the upper core plate, depending on upper internals design (one plant has continuous guidance the entire length of the upper internals guide tube and another has a unique internals and control rod design which does not utilize upper internals guide tubes as described in this paragraph).

P. 2-9 Draft Report: Under Drive Rod Assembly, first paragraph.

Comment: The steps are typically 5/8-inch; however, on several older plants, these steps are 3/8-inch. The travel of the control rod for a 12 foot core plant is typically 228 steps (approximately 142.5 inches).

P. 2-10 Draft Report: "Instrumentation is provided to monitor..."

Comment: Not all plants have such instrumentation.

P. 2-11 Draft Report: "The total insertion time of an RCCA from a fully withdrawn position is approximately 2.2 seconds."

Comment: The total insertion time for an RCCA from a fully withdrawn position depends on the type of fuel and RCCA absorber.

SECTION 3

P. 3-3 Draft Report: Under Mechanical Interaction, last sentence.

Comment: Westinghouse does not feel that there are tight clearances between the RCCA and upper internals guide tube or fuel assembly thimble tubes. Wear of the RCCA is not due to the clearances in these components, but rather due to hydraulic effects.

P. 3-3 Draft Report: Regarding the "Vibration" paragraph.

Comment: The guide tube being discussed should be clarified. Westinghouse is not aware of any degradation of the CRDM guide tube (Figure 7-2), and we are not aware of any motion of the CRD Mechanism caused by flow induced vibration.

P. 3-9 Draft Report: First paragraph, third sentence.

Comment: Replace the third sentence with the following: The mechanical stress caused by the physical impact of the rod with the guide cards results in the formation of localized areas of fretting wear on the cladding surface at points along the control rod length."

P. 3-9 Draft Report: Second paragraph, second sentence.

Comment: Delete the phrase: "...the upper portions of..."

P. 3-13: Draft Report: Temperature primarily affects the insulating quality of the operating coils. Vibration and humidity aggravate the degradation process.

Comment: Coil insulation is provided by a double layer of glass sleeving on the copper wire. This insulation is impervious to temperature degradation at the coil operating temperature. The silicone resin potting material only functions to anchor the glass fibers and conduct heat out of the coils. Since coil temperature affects the coil resistance, the temperature must be controlled.

P. 3-13 Draft Report: Coil connectors are subject to stresses from maintenance activities and boric acid corrosion.

Comment: A large number of vintage plants were equipped with Crouse Hinds electrical connectors. The Crouse Hinds connectors tended to degrade with successive disconnections and reconnections. Therefore, Westinghouse changed connector designs for succeeding plants. The new Pyle National and Litton connectors have been operating with great success.

P. 3-14: Draft Report: The clearance between the coil stack and the CRDM pressure vessel is a critical fit.

Comment: The present clearance could be doubled without affecting CRDM performance. This fit is not critical.

P. 3-14 Draft Report: The clearance between the CRDM coil and the coil housing is critical and must be maintained throughout the life of the CRDM.

Comment: Of the many fits in the CRDM, only those that are subject to change because of wear or corrosion are relevant to aging. The fit between the coil and its housing is constant over the life of the plant, and is irrelevant to the aging question.

P. 3-15 Draft Report: ...elevated levels of ambient temperature and humidity were identified as leading contributors to the failure of components...

Comment: Westinghouse has not been able to confirm that high humidity contributes to failures. A criterion should be provided for this finding.

SECTION 4

P. 4-13 Draft Report: Last two sentences.

Comment: The heat treatment process currently applied by Westinghouse to the support pins has been revised from that stated in the draft report. The details of the process are proprietary to Westinghouse.

P. 4-14 Draft Report: Second paragraph.

Comment: Westinghouse does not consider guide tube misalignment to be credible since alignment is maintained with either or both shank and leaf broken. Upper Head Injection plants (Sequoyah, McGuire, Catawba, and Watts Bar) have a special retainer welded to the bottom of the guide tube flange that prevents the support pin shoulder from dropping out of the counterbored hole in the guide tube flange.

P. 4-15: 3-10 Draft Report: Cyclic fatigue caused several couplings (spider assemblies) to deform beyond usability.

Comment: Cyclic fatigue was not the cause of the widely spread rod drive shaft couplings. Rather, these couplings were deformed by mishandling during refueling. The damaged couplings have been replaced and improved handling techniques have prevented further damage.

P. 4-16 Draft Report: Stationary gripper coils fail due to degradation of the electrical insulation derived from ohmic heating.

Comment: All coil failures have been due to water penetration due to a coolant leak. No coil failures have resulted from either excessive temperature or age. The stationary gripper coils are more likely to fail from a coolant leak than other coils because the water pools at the low point of the coil stack occupied by the stationary gripper.

P. 4-16: Draft Report: Debris-caused mechanical binding in the latch assembly.

Comment: Debris is not an age related phenomenon. Sticking from debris can occur as easily at a new plant as at an older plant.

P. 4-17: Draft Report: Guide screw failures can cause a stuck rod.

Comment: Guide screw failures resulted from an inadequate manufacturing technique. Once discovered, the problem was corrected. The guide screw failures did not result from an age related phenomenon.

P. 4-28: Draft Report: Mechanical wear of the connectors at the coil stack contributed significantly to the number of failure events.

Comment: Most of the failures occurred in the Crouse Hinds connectors (see response to P. 3-13). Most of the operating plants are equipped with an upgraded connector design which is resistant to mechanical wear.

P. 4-11 4-33 Draft Report: "...age significant failure mechanisms have been identified .... inspection results revealed a significant amount of wear on RCCA absorber rods..."

Comment: The fact that some rodlets have demonstrated wear beyond what was expected does not represent a concern with the reliability or drop time performance of the rods. Plants with metallic absorbers have operated with cladding penetrations with no adverse impact on normal operations. Allowing the wear to progress beyond acceptable limits can require premature replacement of the RCCAs, but the proper use of wear management guidelines (including axial repositioning of the RCCAs) can distribute the wear along the cladding surface and extend the operational availability of the RCCAs.

P. 4-33 Draft Report: For the "Rod Shaft Coupling" item.

Comment: The failure mechanism should be changed to "Mishandling." See comment relative to P. 4-15.

P. 4-33 Draft Report: For the "CR Guide Tube" item.

Comment: The report does not provide any information relative to this item with respect to mechanical misalignment of the guide tube due to improper installation. Further, if misalignment of the guide tube was due to improper installation, it would not be an age related problem.

SECTION 5

Table 5-1 ... Mechanism

Nos. 1-6, 9-12	The entries under "Failure Mode" and "Failure Cause" appear to be reversed.
Nos. 1, 2, 3	Latches, drive shaft, and latch pin wear or fracture have a high safety impact which implies a dropped rod accident. Because there are multiple latches and latch pins in a CRDM, this type of failure could produce misstepping or a stuck rod, but not a rod drop. We are not aware of any drive shaft failures.
No. 4	The historic coil open circuit failures were due to reactor coolant leaks, not age.
Nos. 7, 8	The mode here is "failure to step".
No. 11	Improper assembly is not relevant to aging and pertains only to Crouse Hinds connectors. Corrosion by boric acid is not age related, but a random phenomenon depending on the occurrence of coolant leaks.
Nos. 4-12	Some of the failure causes, while valid failure mechanisms, are not necessarily age-related. Since the list of failure mechanisms for each mode is not comprehensive, we infer that BNL has categorically interpreted failures involving these mechanisms as age-related. Accordingly, events irrelevant to aging may have been incorrectly included in the failure count used as a basis of the Failure Frequency categorization. For example, not all open-circuit failures of wires are the consequence of insulation degradation with age; such events could also represent insulation defects introduced in manufacturing, shipping or installation, or inadequate clearance in assembly.
Nos. 5, 6	In the absence of specific information to the contrary, intrusion of foreign material between sliding surfaces should be classified as a random, rather than age-related, process. Often the debris is present at plant start-up or is introduced during a refueling.

Table 5-2 ... Power Cabinet

Nos. 1, 2	These events defeat rod step capability on one RCCA. Even if undetected, such events alone cannot lead to either trip or loss of insertion capability, and should, therefore, be shown as "Low Safety Impact".
Nos. 15, 17	These events do not lead to either trip or loss of insertion capability, even if the operator does not respond to the alarm; they should be "Low" Safety Impact.
No. 18	Event postulates that a group of rods dropping might or might not initiate a trip in future, depending on their combined reactivity worth. (The past events should be reviewed to determine whether a drop would occur under the revised trip logic accepted by NRC.)
Nos. 8, 10	Fuse failure mechanisms are implied to be aging-related. There is evidence to the contrary; the review summarized on pages 4-25, and Appendix B3 imply that of about 9 fuse events (7 per Table B-3), only 3 occurred at a plant in service over 5 years. (Since fuses may be routinely replaced without generating a report, plant age is an extreme upper bound to fuse age).

Table 5-3 ... Logic Cabinet

Nos. 1-3, 5, 7, 8	"Aging due to moisture" is not specific; typically, the moisture source is a random leak occurrence, uncorrelated with plant or component age. Events due to "Manufacturing defect" should be deleted as not age-related.
No. 4	"aging" is not specific [Insufficient] "lubricant" is not aging-related, and seems unlikely as a cause of push button failure.
No. 6	"aging of contact", "arcing" and "moisture" are vague and/or unrelated to age. Corrosion would typically increase contact resistance rather than cause a short.
No. 7	Many board failures do not cause rod drop; see Appendix B, Table B-3. The failure frequency is, therefore, too high.

SECTION 6

P. 6-2 Draft Report: Table 6-1.

Comment: The table appears to be incorrect for the "Age of Plants" for plants G, H, K, and L. Westinghouse does not believe that any Westinghouse plants with Hafnium RCCAs have had initial criticality dates of 9, 10, or 11 years ago. This table should be corrected and any analysis of data associated with these plants which is based on the age of the plant should be revised based on the correct time from initial criticality

P. 6-2 Draft Report: "One had to be replaced due to bulging (hafnium hydride)."

Comment: This particular RCCA replacement was made because there was a bulge in the dashpot interface portion of the rodlet that might have caused operational difficulties in subsequent cycles if it had continued to grow. Westinghouse calculations show that the maximum bulge size (assuming full hydriding of the hafnium cross section) is less than the inner dimension in the guide cards. Therefore, interference in the guide cards is unlikely. Interference in the dashpot region of the fuel is more likely, as the clearance is smaller, but the rod tips have already entered the dashpot region by then, satisfying the drop time requirements.

P. 6-3 Draft Report: "Four plants (C, E, K & L) relocated their fully withdrawn position for shutdown bank rods by 3 steps to avoid localized fretting wear. (Westinghouse recommendation to "distribute" wear)"

Comment: It should be noted that for plants with accelerated wear rates, Westinghouse recommends frequent (once every one or two months) single step repositioning.

P. 6-3 Draft Report: Under "Pressure Boundary Components."

Comment: The item for Plant D concerning rotating the solenoid operated valves does not apply to this report. These valves are associated with the Reactor Vessel Head Vent System, and are not the CRDM Vent Valves. Therefore, this item should be deleted from the report since it is not applicable to the CRDM System. Any analysis which included this information should also be corrected.

P. 6-6 Draft Report: Table 6-2, under the "Component" heading.

Comment: "Guide Tube" should be deleted from "RCCA/Guide Tube". Westinghouse is not aware of any eddy current or profilometry inspections being performed on the CRDM guide tube or the upper internals guide tube.

P. 6-11 Draft Report: Section 6.2.1, first paragraph, fourth sentence.

Comment: It should be noted that some plant tech specs address a rod that is inoperable (i.e. misaligned), but still able to trip. In this case, the shutdown margin must also be recalculated and verified to be sufficient within one hour or the plant must reduce its power level.

P. 6-12 Draft Report: Section 6.2.2, first paragraph.

Comment: The control rod drop time and applicable minimum coolant temperature requirements are plant specific, and depend on the particular fuel design and RCCA absorber design.

P. 6-12 Draft Report: Section 6.2.3, first paragraph.

Comment: Control rod absorber materials also include Hafnium and B_4C. The specific length of absorber material in the control rods is dependent upon the specific core design.

P. 6-13 Draft Report: Second paragraph, last sentence.

Comment: The word "group" should be changed to "bank." We also suggest adding a sentence to the end of the paragraph: "Some plants utilize a Rod Drop Test Cart which provides testing of an entire group of RCCAs at a time."

P. 6-19 Draft Report: Section 6.3.3, second paragraph.

Comment: Westinghouse does not believe that the French are inspecting every cycle because of a lack of confidence in the ultrasonic inspection technique. Discussions between Westinghouse and the French have indicated that the inspection technique is considered to be accurate and repeatable. Further, the French have confirmed their ultrasonic inspection results by destructive testing of upper internals guide tube support pins in the laboratory.

SECTION 7

P. 7-3 Draft Report: "...longitudinal crack found on one rodlet. This was determined to be a localized tubing defect."

Comment: Subsequent evaluation has determined that the crack was, in fact, axial hairline tip cracking due to the interaction between the absorber and the cladding, and radiation induced effects in the tip region of the rodlet.

P. 7-3 Draft Report: "This is a safety concern in that wear could result in the loss of absorber material from the rodlet..."

Comment: Several plants have operated with maximum wear depths, including cladding penetrations, with no adverse impact on normal operation. The metallic absorbers (Ag-In-Cd and Hf) are stable in the presence of the coolant environment, and the reliability and drop time performance would be maintained. There is no loss of absorber material other than that which occurs by the absorber wearing directly on the guide cards.

P. 7-6: Draft Report: CRDM canopy leaks may result in rod ejection.

Comment: This is not true. Acme threads bear the load while canopies retain the pressure.

P. 7-8 Draft Report: It is recommended that the CRDMs be periodically inspected for wear.

Comment: There is no evidence to support this recommendation. All CRDMs will survive plant life. Both Framatome and Mitsubishi have demonstrated that CRDM life exceeds 10 million steps.

P. 7-8 Draft Report: It is recommended that a program to determine the integrity of CRDM seal welds be developed.

Comment: This is neither practicable nor warranted by past experience. Only four CRDM welds have leaked. Most canopy leaks have occurred in head adapter plugs and instrumentation ports.

P. 7-8 Draft Report: The principal safety concern associated with this effect [swelling and cracking of hafnium control rods] is the inability of a control rod to fully insert into the core because of interference between control rods and guide tubes.

Comment: See comment relative to P. 6-2.

P. 7-10 Draft Report: Last paragraph.

Comment: See comments relative to P. 4-13. Also, the last sentence should be replaced with: "Reduced torque values for the lock nut have been specified. These torque values are plant specific due to the variations in applied operational loads."

P. 7-14 Draft Report: Coil insulation is subject to high temperature degradation.

Comment: See comment relative to P. 3-13.

SECTION 8

The conclusions do not appear to be derived by a formal statistical review of the available experience. Lacking such objective analysis, the findings are open to debate. Specific examples are given below.

<u>Section 8.1.2 - Operating Experience</u>

o Finding 1

40% of CRDS failures is said to occur in the cabinets; given the high population of components in the two cabinets this is not surprising. High ambient temperature is cited as the primary cause throughout the FMEA tables. While prolonged exposure to high ambient temperatures is an important stressor for electronic components, specific failure events may be a failure caused by a short-term abnormal temperature originating in some random circumstance. The rate of occurrence of such failures would not correlate with plant age.

For a system under observation for periodic replacement, a reduction in part life does not necessarily constitute a safety concern since parts may be redundant, monitored, or periodically replaced. That is, the unavailability of a maintained system will not necessarily increase with time. Likewise, discovery and removal of a high ambient temperature condition, as has presumably occurred at some plants, eliminates the correlation with plant age in subsequent operation.

o Finding 2

The finding states that many CRDS failures result in rod drops, and describes these as a safety concern.

As noted previously in the General Comments, Westinghouse has shown to the satisfaction of the NRC that occurrence of a negative flux rate of limited magnitude does not require a trip. Therefore, as plants update their protection systems, no single or multiple dropped rod will initiate a reactor trip. Future trip rates will, thus, be reduced.

o Finding 3

RCCA wear is stated to be due to sliding and fretting wear and to stress corrosion cracking. We do not see how this finding is supported by the BNL data evaluation.

o Finding 4

It is irrelevant to this study that stress corrosion cracking has occurred in reactor fuel assembly components. Again, no explanation is given as to how this finding was derived from the BNL data evaluation.

o Finding 5

That energized coils fail more often than normally de-energized coils is not a reasonable assumption. See comment relative to P. 4-16.

o Finding 6

The finding that some boards failed more frequently than others is reasonable, as the cards have differing functions and component populations. To show a statistically significant difference, a formal reliability analysis of board failure rates is required.

o Findings 7 and 8

It is emphasized that all of the reported connector failures occurred at plant ages over 5 years, while fuse failures, which occurred at low plant ages, are also labeled age-related.

o Finding 9

No explanation is given in the text of how the data evaluation served to identify the cited calibration drift problem, or to determine that it was not age-related.

Section 8.1.3 - System Design/Aging Correlation

Despite the section title no correlations are provided, and, in fact, no failure rates are computed. The findings presented appear to be statements of fact made by utilities in reports to NRC, INPO, or in their responses to the questionnaire. The conclusions drawn from each of these facts are generic and not suggestive of new ideas regarding industry or regulatory actions. No basis is given, for example, for such statements as "the stresses from this relatively severe environment appear to be underestimated", in reference to damage due to borated water leaks.

Section 8.2 - Recommendations

- BNL recommends (P. 8-6) that plants with ambient temperatures in the upper head region above 150^{o}F or in the cabinet area above 80^{o}F, should modify their ventilating systems. Imposing such changes on plants, regardless of age, insulation type, cooling air flow, trip rates, assessed safety system availability, cost and possible unwanted side-effects is unwarranted by any evidence presented.

- Replacing CRDS cables is implicitly recommended, again with no basis other than that some utilities have done so; this does not immediately imply that all should do so.

- Future work is recommended on the basis that "this study has identified components within the Westinghouse CRDS whose performance is affected by aging". Our reading of the report reveals no component aging mechanism not previously identified by utilities or in reports of utility-sponsored research. The benefit of pursuing this investigation is, therefore, questionable. Further surveys, site visits and questionnaires regarding plant testing and monitoring will add to the paperwork burden of the plant operator without the promise of results significant to safety.

APPENDICES

P. A-1 Draft Report: Section A.1.

Comment: The following parenthetical statement should be added to the second sentence: "(Westinghouse fuel design also includes a 16x16 array which is not utilized in domestic plants.)"

P. B-10 Draft Report: Table B-4, Item 3.

Comment: For clarity, the following should be added to the Failure Description: "(This occurrence concerns the drive rod breech guide screws.)"

ERRATA

iii	2nd paragraph. "...associated with manual control..." should be "...associated with manual and automatic control..."
1-2	1st line. Forty seven domestic nuclear......
1-3	Under C. "20 to 15..." should be "10 to 15..."
2-4	Figure 2-2. 240 VAC should be 260 VAC
2-17	2nd line. "...contains three dual voltage..." change to "...contains dual voltage (125/70V)..."
2-28	Last paragraph, 2nd line. "...has five digits..." should be "...uses three digits..."
3.9	First paragraph, second sentence; also second paragraph, first sentence. "blocks" should be "cards"
3-14	Change "Coil Fit in Core Housing" to "Coil Fit in Coil Housing", and change ". . . the CRDM and coil housing . . ." to ". . . the coil and coil housing . . ."
4-31	Next to last sentence. Delete "was" for sentence to read: "...detector coil caused an erroneous..."
4-33	3rd column heading. "Failure Case" should be "Failure Cause"
	For the "Rod Shaft Coupling" item, under Failure Cause, "Stread" should be "Spread"
4-35	Under fuse failure mode. "Excessive voltage" should be "Excessive voltage drop"
5-2	Under last guideline. "...effect..." should be "...affect..."
	Table 5-1. Define "ncr" & "fcr"
	Table 5-2. Under No. 3, the line filter is for thyristor di/dt protection, not for smoothing ripples in coil current.
	Table 5-2. Under No. 19 delete "in" at end of "...firing circuit for the lift coils..."
	Table 5-3. Under No. 5, Failure Mode B. Delete "D" or define.

6-4	Under 5. Final item. Change to read "...F upgraded their system to a microprocessor system..."
6-12	Section 6.2.2. Section title should read: "Control Rod Drop Time"
7-3	Sentence beginning with "During normal control rod stepping operations..." The end of the sentence should read: "...sliding interface with the upper internals guide tube."
7-19	Under item 2. "...single trip grippers..." should read "...single tooth grippers..."
8-3	Last sentence. "...card contains thyristors..." should read "...card contains switching transistors..."
8-7	Last sentence of 8.2.1. "...contribute to the cable's degradation..." should read "...contribute to conduction degradation..."
8-8	Middle of page. "...traced during rod notion..." should read "...traced during rod motion..."
9-1	Under Reference 6 & 7. "Solid Stae..." should read "Solid State..."
9-2	Under Ref. 22. "...Used t San..." should read "...Used at San..."
A-1	Figure A-1 is missing from the report.
A-10	Last paragraph. " 7 1/2 amps" and "7.5 amps" should read "8 amps". "4.2 amps" should read "4.4 amps".
B-5	Event number 2 in the circuit board failure list should apparently be for Beaver Valley 1.