UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, D. C. 20555

May 6, 1985

MEMORANDUM FOR: J. C. Ebersole, Chairman
Palo Verde Subcommittee

FROM: G. A. Reed, ACRS Member

SUBJECT: REFLECTION ON PALO VERDE SUBCOMMITTEE MEETING OF APRIL 26, 1985

It would appear that most of the issues in abeyance related to the ACRS letter of December 15, 1981 have been satisfied; and perhaps also most of your questions.

My evaluations from the meeting and plant Unit #2 tour are as follows:

1. Bechtel (The AE) and APS have created a spacious overall facility and the individual units have much above average in containment space, laboratory space, spent fuel handling space, etc. Layout and arrangement of equipment is very good. Excellent permanently installed walkway access inside containment exists. Compartmentalization is good from security viewpoint, but maintainability inside some compartments is only good - mostly caused by pipe-whip structures or seismic restraints.

2. The state of the Unit I toured was that it was essentially complete except for insulation and painting. Also much of the hydrostatic type testing is complete. There were not many workers in evidence on the unit and operating personnel seemed to be deployed for the most part elsewhere on higher priority work of Unit 1. Housekeeping and appearance throughout Unit #2 was excellent. No graffiti was evident -- and since final painting has not been performed, it is obvious that this aspect has been unusually well controlled.

3. I saw no installed equipment, piping, etc. that I could criticize from materials, support or other reasons. Even the charging pumps which were stated earlier not to have suction stabilizers did actually have them quite appropriately installed - except I would have used a larger pipe size between the suction stabilizers and the pump blocks.

4. My quick brush with operating personnel indicates they are natural ability selected for operations and perhaps also for maintenance, I would judge the training activity and people qualification to be good. I did wander in on one or two classes in session and the activity seemed good.

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5. The only problem I have with the Palo Verde units is the "no frills" basic conceptual design of safeguards systems. My tour examination tells me the "start up", or third auxiliary boiler feed pump is not classifiable as a third auxiliary feed pump for safeguards, since it lacks security protection and is with its suction and discharge piping, etc. located very much uncompartmented in the open area of the ground floor of the turbine building. Therefore, Palo Verde core melt protection (safeguards) systems boil down to this:

   - Two (2) Aux Boiler Feed Pumps & Trains (one steam - One elec.)
   - Two (2) HPSI pumps and trains
   - Four (4) accumulators
   - Two (2) LPSI pumps and trains
   - Two (2) steam generators with atmospheric dumps
   - Pressurizer Auxiliary Spray with two (2) parallel enabling valves and three (3) 44 GPM positive displacement pumps - pumps used for other service and which may not be committed beyond one or two available.
   - Two diesels at about 5000 KW each.

For the trends of today toward more redundancy and options to effect core cooling in the most serious and likely situations of SBLOCA - tube rupture; this stack up of systems is the most "lean" I've seen - certainly no frills. A further complication is that several enabling valves are in the normally closed position and with series vs. parallel arrangements. Personally, I would study these valve arrangements more carefully to try to cut down on the number of closed valves.

On the positive side for these lean systems, I feel APS personnel will run a "tight ship" on surveillance and maintenance; that is, the present organization. Also the installations of these lean systems appear as quality jobs.

Seems to me the way to evaluate this "leanness" combined with no backup mode of primary depressization by PORV's, is to ask for a partial plant specific PRA for Palo Verde, and that this PRA be performed on a fairly high priority schedule, say within one year. I believe further evaluation of core melt (safeguards) systems is appropriate for Palo Verde, and if Palo Verde isn't on the A-45 nine plant list for risk of core melt evaluation it should be. I don't believe the other contributors such as fire, seismic, wind, flood, etc. need to be looked at - only the PRA of the safeguards systems.

One should keep in mind that the "leanness" of safeguards systems is an NSSS designer responsibility --- and this only serves to remind us that this "sole licensee" utility structuring of the NRC should shift focus to NRC certification of NSSS designs and designers.

From a operational viewpoint --- not core melt risk related --- I found the pressurizer safety valve installations likely to give Palo Verde some substantial lost production time. The four safety valves are located at the top of four pipes rising almost vertically off the pressurizer --- with no water loop seals. These pipes will certainly fill with pure hydrogen, against which even the best of safety valves will proably leak. Then with leakage and microscopic wire drawing -- more leakage, etc. What will be tolerable? Here again, I got the feeling that systems design for Palo Verde is more vintage 1970 than 1980 as advertised.

cc: ACRS Members

CERTIFIED

MINUTES OF THE
292ND ACRS MEETING
AUGUST 9-11, 1984
WASHINGTON, D.C.

The 292nd meeting of the Advisory Committee on Reactor Safeguards, held at 1717 H Street, N.W., Washington, D.C., was convened by Chairman J. C. Ebersole at 8:30 a.m., Thurday August 9, 1984.

[Note: For a list of attendees, see Appendix I. D. Okrent, G. A. Reed, and P. G. Shewmon did not attend the meeting.]

Chairman J. C. Ebersole noted the existence of the published agenda for this meeting, and identified the items to be discussed. He noted that the meeting was being held in conformance with the Federal Advisory Committee Act and the Government in the Sunshine Act, Public Laws 92-463 and 94-409, respectively. He also noted that a transcript of some of the public portions of the meeting was being taken, and would be available in the NRC's Public Document Room at 1717 H Street, N.W., Washington, D.C.

[Note: Copies of the transcript taken at this meeting are also available for purchase from Free State Reporting Inc., 99 Cathedral Street, Annapolis, MD 21404.]

I. Chairman's Report (Open to Public)

[Note: R. F. Fraley was the Designated Federal Official for this portion of the meeting.

Chairman J. C. Ebersole indicated that the Commissioners granted a full power operating license to the Grand Gulf Nuclear Plant on July 31, 1984. He also noted that at an August 2, 1984 Commission meeting, the Diablo Canyon Nuclear Plant was given a license for full power operation to be effective August 15.

II. Palo Verde Nuclear Generating Station Units 1, 2, and 3 (Open to Public)

[Note: A. Wang was the Designated Federal Official for this portion of the meeting.]

P. Narbut, Project Inspector, Region V, indicated his plan to discuss the following topics:

- Significant construction deficiencies
- Effectiveness of QA program
- Status of preoperational test program

He noted that the Palo Verde management has submitted a large number of 10 CFR 50-55(e) reports. They appear to have a low threshold of reportability of items which have potential

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significance. He indicated that their willingness to report events is good, and the quality of their evaluations is generally technically sound and thorough. He stated that the Applicant has made proper use of outside expertise in evaluations when required. In general, their actions were properly expanded in the technical area to include all units (see Appendix IV). He did point out, however, that the Staff believes some improvement is required in identifying the root causes of reportable items. He speculated that the deficiency may involve a less than orderly design review checkoff or an individual evaluator who just does an inadequate review.

J. C. Ebersole noted that the Applicant is apparently good at identifying the root cause of failures during the preoperational test program, but should have found them before the preop test. He stated his belief that the preop test program ought to be confirmatory and not exploratory. The Committee discussed the large number of failures which occurred during the in-plant preoperational test. Comparison was made of the failures of the reactor coolant pumps at Palo Verde with the materials problems in diesel generators at Shoreham. C. P. Siess suggested that these were both instances of inadequate or improperly qualified equipment or improperly tested equipment such that deficiencies were not discovered until tested on the site prior to operation of the plant. J. Jackson, NRC Qualifications Branch, noted that the reactor coolant pumps at Palo Verde were subject to approximately 150 hours of testing prior to installation. C. P. Siess asked if the pump had been tested under the same flow conditions seen at Palo Verde. J. Jackson indicated that it was tested under runout conditions with maximum flow that would be expected at Palo Verde. C. Michelson asked if the Staff was inferring that each of the pumps was tested for 150 hours. J. Jackson indicated that only the design pump, one pump, was tested.

J. C. Ebersole asked if the Palo Verde Plant was designed to sustain an event such as an overfilling of the steam generator characterized by filling of the steam lines up to the turbine stop valves. C. Michelson wanted to know if the system had been tested for dynamic loading with the steam pipes full without any manual adjustments to the spring hangers. The Applicant indicated affirmatively.

The Committee discussed several significant construction deficiencies dealing with defective structural bolting, faulty electrical terminal lug crimping, and main steam isolation and feedwater isolation valve problems.

P. Narbut indicated that the Staff has found that the QA program at Palo Verde is generally effective in construction activity control by the contractor. Hardware, in general, is built per drawings and the records of the hardware construction are adequate. They have a better than average quality of work done in the field in the electrical and mechanical areas. The Staff has some reservations at this time, however, regarding the kinds of subcontractor work controls. He noted that the SALP review done this year was not as good as the one last year. This could be connected to the startup and operations QA/QC program.

G. McCoy, Assistant Project Manager, Combustion Engineering, explained that a post demonstration test was performed from July 1 to August 5, 1984 to demonstrate the repairs done to the reactor coolant pumps, the CEA shroud, and the RTD thermal wells. He indicated that after review of the preliminary data, it has been found that the results were well within the stringent acceptance criteria established for the operating parameters. M. W. Carbon asked for a summary of the faults regarding the reactor coolant pumps. G. McCoy stated that the reactor coolant pumps used at Palo Verde were designed by KSB in Germany, sold by Combustion Engineering, and tested at Combustion Engineering's Newington Facility. Prior to installation at Palo Verde, these pumps were tested for about 500 hours, and with the exception of minor mechanical fastening problems, and hydraulic problems which were rectified, the pumps successfully passed all tests. C. Michelson asked if there are other pumps of this type used anywhere else. D. Wade, Combustion Engineering, indicated that the Green County Pump manufactured by KSB for service in the U.S. was very similar to the Palo Verde pump. It was also tested for about 800 hours. C. Michelson indicated that he thought these pumps were in routine use in Europe. D. Wade indicated that the hydraulics are slightly different in nuclear plants in Europe. The pumps used here are a more radial pump design than most of European pumps, which are of mixed design. C. Michelson suggested that the European applications had considerably looser tolerances and the clearances were trimmed for the Palo Verde pump because of the need for more flow. D. Wade agreed that the European pumps have higher gaps, particularly at the top of the impeller.

J. C. Ebersole pointed out that the Combustion Engineering System 80 Design is totally dependent upon an absolute guarantee of the integrity of the pressure within the primary coolant loop to maintain a thermal driving head to the secondary side. There is no way to remove decay heat except through the secondary system. He suggested that under conditions of a long term ac power outage, the pump seals will leak creating a small LOCA which will destroy the temperature driving head to the secondary side. He asked what the characteristics of the reactor coolant pumps are in the prolonged absence of ac power regarding the degree of leakage that can be expected. G. Davis, CE, indicated that the pumps at Palo Verde are the first pumps designed to have seal injection flow from the charging system which is the safety grade means of providing charging flow to the seals. J. C. Ebersole suggested the scenario of a total blackout with no ac power and no diesels. He asked how CE provides flow to the seals. G. Davis admitted that this would be a situation where there would not be seal injection flow. He countered, however, that the seals would still maintain their integrity for some finite amount

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of time. J. C. Ebersole pressed for a quantitative estimate of the amount of time involved and the accompanying leak rate, since it was important to the question of preservation of the overtemperature driving force to the secondary side. J. Jackson indicated that the Byron/Jackson type pumps which are used in other CE plants have been tested for a 50 hour station blackout. That is the type of seal being discussed here.

G. McCoy explained that the damage to the reactor coolant pumps involved the following:

- Broken impeller vanes on two of the pumps
- Loose diffuser bolts
- Broken diffuser bolts and some limited cavitation damage on the diffuser

He discussed instrumented tests done at CE's Newington facility and design changes that were made to the pumps to substantially reduce stresses during runout operating conditions. He noted that definitive testing of instrumented impeller blades confirmed that thicker impeller blades made a measurable difference regarding static and dynamic loads on the impeller blades in the critical area.

J. C. Ebersole asked about the ultimate potential effects of having extensive damage in the upper guide shrouds. G. McCoy indicated that the guidance fingers provide no function during the course of operation of the plant, but are basically to provide guidance during refueling. If a crack were to propagate in the shroud, it is conceivable that many of the guidance fingers might simultaneously fail, and prevent insertion of a number of control element assembly (CEAs) (stuck rods). He indicated that structural and vibration testing was done to investigate the stuck rod possibility. Tremendous cross flows were found in the two bank region, and it was determined that the natural frequency of these tubes corresponded to the driving frequency of the reactor coolant pumps. To design away from that frequency, the plates were moved upward to increase the frequency of the tubes above that of the driving frequency.

G. McCoy explained that thermal wells which contain the resistance temperature detectors (RTD) in the primary loop had failed due to fatigue caused by high runout flows which caused vortex shedding. He indicated that the resistance temperature detector thermal wells in the cold leg were beefed up to be more rugged, and tapered to reduce the effects of vortex shedding at the tip. Regarding loosening of the safety injection nozzle thermal sleeves, G. McCoy indicated that these thermal sleeves were removed from all CE plants except for the charging line. It was found that the problem was caused by vibration and rotation of the thermal sleeves. Since removal of the thermal sleeves, there has been no need to pursue the problem any further. The failure to start of low pressure safety injection pumps was attributed to an overcurrent trip. When current was applied to the motor, the pump began to rotate causing a larger current flow through the motor. This intermittent complex problem was solved by interchanging a higher horsepower containment spray pump motor for the original low pressure safety injection pump motor. He indicated CE's belief that the larger diameter shaft associated with the higher horsepower motors prevented the shaft deflection that resulted eventually in the overcurrent trip. J. C. Ebersole pointed out that the larger motor resulted in a more rigid shaft, and a more rigid shaft was the solution to the problem. G. McCoy agreed.

L. Crocker, NRC, indicated that Palo Verde is better prepared from an onshift operating experience point of view than Diablo Canyon (see Appendix). He indicated that Arizona Public Service Company (APS) will have an independent STA on shift. F. J. Remick asked regarding the status of Palo Verde training programs with respect to INPO accreditation. E. Van Broch, APS, indicated that the program would be completed in the next two years.

T. Marsh, NRC, discussed the single failure of the pressurizer spray system. This plant does not have PORVs. As an alternative means to depressurize the plant for events where the steam generators are not available, a safety grade pressurizer spray system which uses basically the safety grade charging system has been designed as an alternative means to depressurize. He indicated that the Staff is concerned regarding failure of the single available valve which provides water from the charging system to the sprays. He noted that while there is a safety grade solenoid on this valve, there is a non safety grade air supply to this valve. He indicated that the solution proposed by APS is to put an isolation valve upstream of the single valve (may stick open) to guarantee closure and flow to the pressurizer spray. This isolation valve would of course, have to be properly qualified. The Committee discussed the vulnerability of the single valve sticking in an open position, diverting and preventing flow to the spray system. Loss of power to the solenoids or loss of the air supply to the valve would normally cause the valve to fail closed under spring pressure.

J. C. Ebersole noted that it is not possible to get water into the primary system when ac power is unavailable. He pointed out that other designs have developed dedicated diesels, or hydraulic pumps driven by mechanical engines, to supply fluid when needed when there is loss of ac power. He wondered why the Staff had not discussed the rationale for setting a requirement for this extremely critical function for the CE design. G. Davis, CE, suggested that the situation postulated was a multiple failure scenario involving a station blackout. He suggested that this will be part of the design basis for Palo Verde and it is a concern for every nuclear plant in the U.S. T. Marsh indicated that every plant has accumulators, and if the plant has a depressurization capability, one may be able to get flow from the accumulators into the primary system as has been suggested in Italy and Switzerland. He recognized that this plant has no capability of depressurizing other than opening the atmospheric dump valves and steaming the steam generators. By taking advantage of the contraction resulting from blowing off some of the secondary coolant there would be some depressurization. J. C. Ebersole pointed out that this would still depend upon the existence of the thermal driving head to produce a lower pressure in the secondary.

G. Mazetis, NRC, discussed the use of symptomatic generic procedures to deal with the multiple steam generator tube failure scenario. He explained that once the multiple steam generator situation is identified, the operator is instructed to isolate the worst steam generator from the viewpoint of radiation. J. C. Ebersole asked what would be done if one did not have the choice of which steam generator to isolate. G. Mazetis indicated that one would steam or allow secondary flow out of the good steam generator or the one with the smallest leak to the condenser. T. Marsh mentioned a multiple tube rupture analysis done for the 3800 Class CE reactors assuming three ruptured tubes in each steam generator and continuous steaming. J. C. Ebersole and D. A. Ward expressed interest in the integral analysis. T. Marsh indicated it was identified as report number CEN 239 and has been sent to the ACRS. In answer to a question by D. A. Ward, T. Marsh indicated that the maximum offsite dose to an individual was reported at 200 rem to the thyroid assuming a preexisting iodine spike. J. C. Ebersole asked how that accident finally terminated. T. Marsh explained that primary coolant continued to be lost out of the break at a rate so as not to overfill the generator. Eventually RHR reentry conditions were reached, and the primary system depressurized.

III. Reactor Operating Experience (Open to Public)

[Note: R. Savio was the Designated Federal Official for this portion of the meeting.]

E. Rossi, Events Analysis Branch, IE, presented two groups of recent significant operating events (see Appendix VI). He indicated that Staff members were prepared to present detailed description of seven events that IE thought particularly interesting. He noted that the Staff was also prepared to make a special presentation on a very recent event, a total loss of all ac power at Susquehanna 2.

E. Rossi explained that an automatic scram was initiated on June 23, 1984, at Fort St. Vrain due to high helium pressure in the prestressed concrete reactor vessel. Six of 37 cable-driven control rod pairs failed to insert on trip and were manually driven in within approximately 20 minutes of the automatic scram. He noted that high moisture content in the primary coolant preceded this event and a previous similar event which incurred

EBERSOLE
4/13/85

AGENDA ITEMS FOR PALO VERDE SUBCOMMITTEE MEETING
APRIL 27, 1985 - PHOENIX, AZ - SOMEWHERE NEAR AIRPORT

Meeting in morning. Plant tour by those who wish (not JCE) after meeting. I have a plane out to return about 4:00 P.M.

Suggest start at 8:30 A.M., close for lunch, and subsequent field trip about 12:30 P.M.

TOPICS

A.

1. Current Plant Status - Projection of work to be completed before escalation to full power.

2. Full Power Escalation Program

3. Chronological List of Significant Unexpected Findings during Hot testing and 5% Power Testing. Include all Valve Malperformance Findings.

4. In view of the extreme reliability required of the main and auxiliary feedwater system:

   a. Describe why applicant believes he will not experience those cases of complete loss of feedwater at PWRs which have actually occurred.

   b. Discuss anticipated frequency of use and frequency of real need of auxiliary feedwater system.

5. As a topic to focus on valve reliability, provide a discussion of the isolation valves for the chemical volume and control system. Include:

   a. Reading the specifications for the valves as they relate to power supply, trip signals, and design basis to close on open discharge at full system pressure.

   b. Describe arguments for ability to close while delivery faulted flow. If only analytical, describe analysis. If by test, describe test.

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c. If outboard piping fails and flow is not intercepted until interior or exterior valve is manually closed (if it can be) describe ultimate consequence in context of equipment damage in auxiliary building and core damage, if any. If core damage occurs, define off-site dose.

B. Discussion with Operating Staff

1. Describe (on a personal basis) the most critical accident situation you are required to mitigate by operator action. Name about six of these and include multiple steam generator tube failures, loss of service water, loss of component cooling water, and loss of DC power to the "safety" systems. What will be the visible effects of loss of the two most critical DC system in respect to control room indications.

2. Discuss and express your view as operators, having been handed a given engineering design, your opinion as to whether you have adequate assets (or perhaps too much information) to perform the above emergency functions in respect to the following areas:

   a. adequate (and not too complex) instrumentation for the initial conditions

   b. an appropriate degree of automatic response of equipment

   c. Reasonably simple accident recovery procedures

   d. Adequate time to perform the recovery function

   e. Instrumentation which will accurately confirm or deny that proper recovery action has occurred, and

   f. Adequate prerogatives to reverse corrective actions in case human error has occurred.

3. Describe the difference, as you understand it between direct and indirect instrumentation indications. Include both process parameters (pressure, temperature, etc.) and equipment functional performance indications. List the "indirect" indications for which some confirmatory evidence of correct actual system or equipment response must be invoked.

4. There are two broad classes of safety-related systems in the plant. One of these is the specialized set of systems designed to mitigate the classical "LOCAs." What are the "others?" Which do you consider to be more important to safety?

5. How did you determine the existence of the "other" systems. Are all of these systems on something equivalent to "Q" list?

6. In your plant, when one of these "other" systems fail, does an operations disturbance occur which requires even more rigorous performance of the residual equipment performing the same critical function?

7. If the residual equipment is on standby (an example might be service water or component cooling pumps) and the first "channel" failure demands auto-start of the backup equipment:

   a. Do you have redundancy after the first failure (as you do with the on-site diesel generators)?

   b. If you do not, how much time do you have, in the most critical cases, to restore the needed function in case the standby system fails to respond to the start-up challenge?

   c. Redundancy is always provided in the ECCS systems which respond to a LOCA. How do you rationalize the absence of redundancy (if such cases exist) in the light of critical service system functional failures which will be much more frequent than LOCAs?