LIMITING CONDITION FOR OPERATION (Continued)

ACTION: (Continued)

b) The SHUTDOWN MARGIN requirement of Specification 3.1.1.2 is determined at least once per 12 hours.

Otherwise, be in at least HOT STANDBY within 6 hours.

d. With one full-length CEA inoperable due to causes other than addressed by ACTION a., above, but within its above specified alignment requirements, operation in MODES 1 and 2 may continue pursuant to the requirements of Specification 3.1.3.6.

e. With one part-length CEA inoperable and inserted in the core, operation may continue provided the alignment of the inoperable part length CEA is maintained within 6.6 inches (indicated position) of all other part-length CEAs in its group and the CEA is maintained pursuant to the requirements of Specification 3.1.3.7.

SURVEILLANCE REQUIREMENTS

4.1.3.1.1 The position of each full-length and part-length CEA shall be determined to be within 6.6 inches (indicated position) of all other CEAs in its group at least once per 12 hours except during time intervals when one CEAC is inoperable or when both CEACs are inoperable, then verify the individual CEA positions at least once per 4 hours.

4.1.3.1.2 Each full-length CEA not fully inserted and each part-length CEA which is inserted in the core shall be determined to be OPERABLE by movement of at least 5 inches in any one direction at least once per 31 days.*

* with the exception that CEAs 27 and 41 are exempt from this surveillance requirement until restart from the second refueling outage.

H. Study of the Risk Impact of a 90 Day Suspension of Surveillance Testing for Two Unit 2 CEAs

1.0 SUMMARY

The study shows that even under a series of conservative modeling assumptions the incremental core damage risk incurred by suspending testing of two CEAs for a 90 day period is much less than 1% of the base case PRA core damage frequency for PVNGS Unit 2. This conclusion is arrived at by analyzing the combined probability of a reactor trip and subsequent RCS overcooling along with the failure of both of the parked CEAs to insert on demand. This was determined to be the only situation under which failure of these two CEAs to insert could potentially lead to fuel damage.

2.0 INTRODUCTION

Two CEAs in PVNGS Unit 2 have been withdrawn fully from the core and "parked" due to significant indications of ground shorts in their coil assemblies. While in this position, the CEAs will not be moved for normal operations, but will still drop into the core upon a scram signal. In order to avoid the possibility of one of these faulty CEAs slipping during the exercise, exemption from the monthly surveillance testing of these two rods during the next 90 day period is desired.

Since these CEAs will not be tested during this period there is an increased probability that one or both of them would fail to fully insert given a scram signal. In such an event the primary safety concern is the possiblity that the reactor will not be taken subcritical or that subsequent RCS overcooling will permit a return to criticality in the vicinity of the stuck rods. It was the intent of this study to investigate the additional risk of inducing fuel element damage that would be incurred by operating the unit without performing the monthly ST on the parked CEAs for a 90 day interval.

3.0 METHODOLOGY & ASSUMPTIONS

Investigation by the Nuclear Fuel Management group has indicated that the reactor will be taken subcritical even if the two CEAs of concern fail to insert as long as other failures don't occur which would result in major RCS overcooling. For this reason the the only accident conditions addressed by this study were those involving significant RCS overcooling

in conjunction with failure of the two CEAs to insert.

The scenarios identified as having the potential for significantly overcooling the RCS were:

A) Main Steam Line Break or spurious opening of multiple Main Steam Safeties (MSSVs), Atmospheric Dump Valves (ADVs), or Turbine Bypass Valves (TBVs) while at power.

B) Any transient leading to reactor trip and subsequent failure to reclose of the ADVs, MSSVs, or TBVs that normally function to provide steam generator steam relief.

In order to determine the probability of incurring fuel damage due to either Case A or Case B above, the incremental likelihood that the two parked CEAs fail to insert is needed. There is nothing related to the grounding fault problems with the CEAs that would incline them to have a different probability of failing to insert than any other CEAs. Only the period of time that elapses between tests of the rods may cause the failure to insert rate exhibited by these CEAs to differ from that of the others.The true failure mechanism that causes a CEA to stick most likely has both a time-related and a demand-related component to it. That is, wearout of certain parts due to rod movement demands probably contributes to a rod sticking, as does certain time-dependent mechanisms such as corrosion and aging effects. Thus, it is possible that the suspension of testing for these two CEAs for this modest interval may have no impact on (or even decrease) their failure to insert probability. For this study it will be conservatively assumed that their failure rate is entirely time-dependent, such that the probability of a rod failing to insert on demand is a linear function of the time since it was last tested.

An estimate of the hourly stuck rod failure rate for PVNGS may be made by dividing the number of occurences of a rod sticking by the total CEA commercial operating hours for all 3 units. There has been one occurence of a rod sticking in the approximately 3.9×10^6 CEA commercial operating hours to 12/20/89 (Based on the 89 full and partial length CEAs in each unit). Table 1 below shows that the derived stuck rod hourly failure rate for PVNGS falls very close to that given in INPO Report 87-022 for C-E plants. It should be noted that the latter rate is based on 2.4×10^7 CEA hours in all C-E plants between 1981 and 1985.

TABLE 1. HOURLY CEA FAIL-TO-INSERT RATES

PVNGS (3 Units, 1 event)	2.6×10^{-7} /h
INPO Report 87-022	2.1×10^{-7}/h

For comparison purposes the demand failure rate for the CEAs was also calculated based on the single stuck rod event and the summed "totalizer" counts for all CEAs in all three

units. The total number of CEA "demands" was found to be 4.6×10^6 to 12/20/89. Table 2 shows the PVNGS estimated rate in comparison to the value used in the System 80 PRA conducted by C-E.

TABLE 2. DEMAND CEA FAIL-TO-INSERT RATES

PVNGS (3 Units, 1 event)	2.2×10^{-7} /demand
C-E System 80 PRA	3.0×10^{-5} /demand

Here the large difference is probably due to the fact that the C-E data is based only on total "scram" events, whereas the PVNGS value considers all rod movements as demands. Again, only the hourly rates were used in determining stuck rod probability for this study.

The scenarious of concern involve both parked CEAs failing to insert. The joint probability of this event cannot be simply calculated as the product of each rods failure probability since it will be dominated by common cause failure of the two CEAs to insert. The C-E System 80 PRA gives a conservative beta factor for common cause of two CEAs to insert of 0.2. The value is derived from NRC documents concerning ATWS (notably SECY-83-293). Applying this beta factor to the PVNGS single stuck rod hourly failure rate gives a failure rate for two CEAs failing to insert of 5.2×10^{-8} /h.

Case A: Main steam line break or multiple spurious open of steam relief valves.

Either a severe main steam line break (MSLB) or the spurious opening and failure to reclose of more than one ADV, MSSV, or TBV will trip the reactor and subsequently overcool the RCS to the extent that a localized return to power is of concern. Although it is likely that such a power transient would be self limiting due to the coolant voiding in the fuel assembly channels, this cannot be assured without detailed neutronic/thermal-hydraulic analysis. As such, it is conservatively assumed for this analysis that the Case A scenario in conjunction with the two CEAs stuck leads to some degree of fuel damage. The yearly frequency for MSLB or multiple failures of steam relief valves was obtained from the C-E System 80 PRA (Pg 6-11). The documents median value was converted to a mean of 2.7×10^{-3}/y. This was conservative in that it includes stuck open TBVs even though such an overcooling transient could be readily terminated by closing the MSIVs. The incremental risk incurred in Case A due to suspending testing of the parked CEAs for 90 days may now be estimated as:

Incr. Fuel Dam = Prob of MSLB in 60 days * Mean prob both CEAs stick

$$[2.7 \times 10^{-3} / 8760\ \text{h} * 60\ \text{d} * 24\text{h/d}] * [.5 * 5.2 \times 10^{-8}/\text{h} * 60\ \text{d} * 24\text{h/d}]$$

$$= 1.6 \times 10^{-8}$$

Incr Fuel Damage = Prob of plant trip/60 d * Mean prob both CEAs stick
* Prob 2 or more MSSVs stick open
$= 1\text{trip} * [.5 * 5.2\times10^{-8}/\text{h} * 60\text{d} * 24\text{h/d}] * [4\ \text{MSSVs} * 2\ \text{SGs} * 8\times10^{-4}]$
$= 2.4\times10^{-7}$

Again, 60 days represents the additional exposure time of the untested CEAs over and above the normal 30 day interval between tests.

It should be noted that in both cases the common cause failure exposure time was assumed to be increased by the suspension of testing of the parked CEAs. This is another conservatism since the mechanism(s) that lead to common cause failure to insert of CEAs are the same for ALL the CEAs. Thus, in reality even the parked CEAs are tested for common cause failure whenever any CEA is tested.

4.0 RESULTS

The increased risk of fuel damage due to suspending testing of two Unit 2 parked CEAs for 90 days is estimated as the sum of the contributions from Cases A & B described in Section 3.0:

$$\text{Incremental prob of fuel damage} = 1.6\times10^{-8} + 2.4\times10^{-7} = 2.6\times10^{-7}$$

This is much less than 1% of the total core damage frequency of approximately 1.0×10^{-4} which is anticipated when the PVNGS PRA is completed.

5.0 CONCLUSIONS

The study showed that the incremental core damage risk incurred by suspending testing of two CEAs for a 90 day period is not a significant concern. Even under a series of conservative modeling assumptions the risk of even localized fuel damage is much less than 1% of the base case PRA core damage frequency for PVNGS Unit 2.

If testing of the two parked CEAs is suspended while at power even the small incremental risk incurred could be further reduced by appropriate briefing of operators on the stuck rod/ RCS overcooling scenario. Maximum boration should be initiated as soon as possible in the event the rods don't insert following a scram.

Note that 60 days represents the additional exposure time of the untested CEAs over and above the normal 30 day interval between tests. Thus this calculation will yield the increase in risk above that normally incurred.

Case B: Any transient leads to reactor trip and ADVs, MSSVs, or TBVs that normally provide steam relief fail to reclose leading to RCS overcooling

Failure to reclose of any single one of these steam relief valves represents a much less severe overcooling transient than a MSLB and was assumed here to be insufficient to cause a return to power. In addition the induced overcooling would progress slowly and provide ample time for the operators to either isolate the open valve (in the case of the TBVs) or to initiate boration via the HPSI or charging pumps. At least two steam relief valves were assumed to have to fail to reclose in order to induce severe enough RCS overcooling to cause a return to power.

The yearly frequency of all reactor trips as employed in the PVNGS PRA is 4/yr. This reduces to .66 in the 60 day extension interval that the parked CEAs are exposed to. It was conservatively assumed for this analysis that one plant trip occurs in this time period.

Industry failure data indicates that the MSSVs have the highest likelihood of failing to reclose after opening so they were selected to represent the stuck steam relief valves for this analysis. There are ten MSSVs per steam generator and it was assumed that four of the valves on each generator lift subsequent to plant trip. This was again a conservative assumption based on the relief capacity of each MSSV. The PVNGS PRA failure rate for an MSSV sticking open is 8.0×10^{-3}/demand. This is the value determined by combining data from several sources as derived in the MONJU PRA. The probability of two or more MSSVs sticking open will be dominated by common cause factors. NUREG/CR-4780 (Pg 3-58) provides an estimate of a generic beta factor for PWR safety/relief valves of .07. This value was conservatively increased to .1 for this analysis due to the uncertainty in applying such generic data to a specific plant. The resulting probability for two or more MSSVs failing to reclose after opening is 8×10^{-4}/demand. The C-E System 80 PRA gives a frequency of 6.0×10^{-4}/y for multiple MSSVs sticking open. If 4 trips per year are assumed and the MSSVs are assumed to be demanded subsequent to one of them, the demand rate derived above is equivalent to a frequency of about 6.4×10^{-3}/y. (4 MSSVs * 2 SGs * 8×10^{-4}). This appears conservative relative to the C-E value.

The incremental risk of incurring fuel damage in Case B due to suspending testing of the parked CEAs may now be estimated as: