Station Support Department
10 CFR 50.90

PECO ENERGY

PECO Energy Company
Nuclear Group Headquarters
965 Chesterbrook Boulevard
Wayne, PA 19087-5691

August 28, 1994

Docket No. 50-277
License No. DPR-44

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

Subject: Peach Bottom Atomic Power Station, Unit 2
Response to Request for Additional Information Regarding Technical Specifications Change Request No. 93-02 (ASD RAI-4) and Supplemental Information Concerning Our Response to Request for Additional Information (ASD RAI-3) submitted August 17, 1994

Dear Sir:

Attachment 1 is our response to your request for additional information (ASD RAI-4) regarding Technical Specifications Change Request No. 93-02 concerning the implementation of the end-of-cycle Minimum Critical Power Ratio Recirculation Pump Trip (MCPR-RPT) System at Peach Bottom Atomic Power Station (PBAPS), Unit 2.

Attachment 2 is supplemental information concerning our previous response to ASD RAI-3, which was forwarded to you in our letter from G. A. Hunger, Jr. to U. S. Nuclear Regulatory Commission dated August 17, 1994.

If you have any questions, please contact us.

Very truly yours,

M. C. Kray for

020055

G. A. Hunger, Jr.
Director - Licensing

Attachments

cc: T. T. Martin, Administrator, Region I, USNRC
W. L. Schmidt, USNRC Senior Resident Inspector, PBAPS
R. R. Janati, Commonwealth of Pennsylvania

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COMMONWEALTH OF PENNSYLVANIA :

: ss.

COUNTY OF CHESTER :

W. H. Smith, III, being first duly sworn, deposes and says:

That he is Vice President of PECO Energy Company; the Applicant herein; that he has read the enclosed response to the NRC request for additional information concerning Technical Specification Change Request (Number 93-02) for Peach Bottom Facility Operating License DPR-44, and knows the contents thereof; and that the statements and matters set forth therein are true and correct to the best of his knowledge, information and belief.

William H. Smith III

Vice President

Subscribed and sworn to

before me this 28th day

of August 1994.

Erica A. Santori

Notary Public

Notarial Seal
Erica A. Santori, Notary Public
Tredyffrin Twp., Chester County
My Commission Expires July 10, 1995

Docket No. 50-277
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ATTACHMENT 1

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION (ASD RAI-4)
Peach Bottom Atomic Power Station, Unit 2

Question 1:

PECO Energy Company indicated that pre and post installation testing will be performed to assure that harmonic current from the adjustable speed drive will be within established limits. Define what is meant by established limits.

Response:

As discussed in our conference call of August 16, 1994, voltage Total Harmonic Distortion (THD) is the parameter that will be measured. Therefore, our responses are primarily based on voltage THD rather than current THD.

PECO Energy Company established a requirement in its equipment procurement specification that voltage THD from the operation of the Adjustable Speed Drives (ASDs) would not exceed 3%. The purpose for establishing this limit was to ensure that when the THD contribution resulting from operation of the ASDs is combined with the contribution from operation of existing plant equipment, the total voltage THD will be less than 5%. Post-installation testing will be performed.

Question 2:

Describe surveillance/periodic testing to be performed which will assure that harmonic current will be maintained within established limits at Class 1E electrical equipment?

Response:

Periodic measurements of the Class 1E bus voltage THD values will be performed as part of a preventive maintenance task to monitor performance of the ASD harmonic filters. The acceptance limit for this testing will be established such that THD values greater than 5% in any portion of the plant electrical distribution system will not be acceptable. The frequency of this test will be based on evaluation of test results.

Question 3:

What percentage of the harmonic current of 3% (or of the established limit) on the 13 kV non-Class 1E switchgear power bus will flow to Class 1E electrical equipment?

Response:

Under normal power operation, the plant electrical configuration precludes the Class 1E electrical equipment from experiencing any significant increase in voltage THD levels due to operation of the ASDs.

The voltage THD caused by the ASDs is a function of its output, the loading on the associated electrical system, and the electrical distribution system alignment. Under normal full power conditions, the Class 1E electrical system is not connected to the buses feeding the ASDs, since these auxiliary buses are supplied by the main generator. Under this alignment, the Class 1E electrical system will not experience any increase due to ASD operation. Under normal full power operating conditions, the non-safety related 13.8 kV buses, which supply the ASD, will experience an increase of approximately 2.1% voltage THD.

Under conditions when the ASD auxiliary buses are fed by the same source (startup transformer) as the Class 1E system, the harmonic distortion of the Class 1E system may increase. This alignment normally occurs during startup and shutdown conditions. When reactor power is low, the ASD speed will be limited due to an interlock with the feedwater system. This interlock does not allow the ASD to increase above 30% speed unless total feedwater flow is greater than 20%. This feedwater flow equates to approximately 20% reactor power. Based on this condition, the maximum voltage THD increase will be 1.1%. Under cases when the associated ASD harmonic filter fails, this value could increase to 2.2%. With reactor power greater than 20%, the auxiliary buses are transferred over to the main generator.

On rare occasions, the reactor may be at power greater than 20% with the ASDs being supplied by the startup transformers. The voltage THD contribution at the Class 1E buses based on this condition will be 2.3%. In the unlikely event of a failure of the ASD harmonic filter under this circumstance, the maximum contribution to the voltage THD on the Class 1E system is 6.5%. Based on this possibility, operational procedures will direct reducing the ASD speed to less than 50% on the failure of a harmonic filter. Failure of a filter will result in an alarm in the main control room.

The following table summarizes the limiting results of the harmonic analysis performed for the PBAPS, Unit 2 electrical system with the ASDs installed. These values are summarized from the General Electric (GE) report entitled, "Power System Harmonic Study for Peach Bottom Nuclear Power Plant." An excerpt of this report is provided as Attachment 3.

PLANT CONDITIONS				LIMITING VALUES FOR %THD CONTRIBUTION DUE TO ASDs		
# OF 13KV BUSES ON SU XFMR	ASD SPEED (%)	# OF BUS FLTRS OPER.	# OF BUS FLTRS INOP	13.8 KV BUS THD(%)	4.16KV BUS (1E)	480V & 120V BUSES (1E)
0	100	2	0	2.1	0	0
0	100	1	1	5.3	0	0
0	80	2	0	2.3	0	0
0	80	1	1	4.7	0	0
0	60	2	0	1.7	0	0
0	60	1	1	3.1	0	0
1	100	2	0	2.3	2.3	2.1
1	100	1	1	6.7	6.5	6.0
1	80	2	0	2.6	2.6	2.3
1	80	1	1	5.9	5.8	5.3
1	60	2	0	1.9	1.8	1.7
1	60	1	1	3.9	3.8	3.5

Question 4:

At PBAPS, will electrical, instrumentation, and control system equipment associated with or connected to the 4.16 kV or lower voltage Class 1E buses (including equipment's protective systems) operate satisfactorily with a harmonic current of 5% superimposed on the input voltage by operation of the proposed adjustable speed drive.

Response:

At PBAPS Unit 2, all electrical, instrumentation, and control system equipment associated with or connected to the 4.16 kV or lower voltage Class 1E buses (including equipment's protective systems) will operate satisfactorily with a voltage THD of 5%. It should be noted that the ASD voltage THD contribution varies, and is discussed in our response to Question 3. Under conditions when the harmonic filter fails, voltage THD levels could increase above 5%. Under this condition, procedures will direct operators to take prompt action to reduce ASD speed, thus reducing its harmonic injection current to maintain voltage THD to less than 5%.

During the time that the operator is reducing the ASD speed to reduce THD levels, the Class 1E electrical system will be exposed to voltage THD levels above 5% only if the following three conditions exist simultaneously: 1) the ASD filter is failed, 2) the ASD is powered from a startup source, and 3) the ASD speed is greater than 65%. In order to ensure that Class 1E equipment will not be impacted by this low frequency event, an evaluation of the PBAPS, Unit 2 safety related equipment was performed. The results of this evaluation are summarized as follows:

a) Increased voltage THD will result in an increase of harmonic heating in electro-mechanical relays, motor windings, transformer windings, and cables. This increase in heating does not pose an immediate threat to the equipment. Rather, it results in a temperature rise within the component. The component temperature rise will be limited by the reduction in THD by reducing the ASD speed.

b) Increased voltage THD levels could impact plant instrumentation. A detailed review of all of PBAPS, Unit 2 safety related instrumentation and control components was performed to determine their associated power supplies. All of these instruments except one were determined not to be fed directly by the Class 1E electrical system. Rather, these components rely upon power supplies which are fed by the Class 1E system. These separate power supplies consist of the Reactor Protection System Motor Generator (RPS MG) sets, static inverters, station batteries, or individual instrument power supplies. Though increased voltage THD may exist on the Class 1E electrical system, these power supplies will act to isolate their respective loads. For example, the RPS MG sets are fed from a Class 1E 480 VAC source. An increase in THD on the 480 VAC supply will result in heating of the MG set motor, but the THD will not effect the 120 VAC output which supplies RPS instrumentation and logic relays.

The one instrument which was not fed by a separate power supply was the High Pressure Coolant Injection (HPCI) Steam Supply Drain Pot level switch. This float type mechanical switch actuates to drain the HPCI steam line of condensation to the main condenser in standby conditions. Harmonic distortion will not effect this mechanical instrument.

The emergency buses degraded grid protective relays at PBAPS, Units 2 and 3, are peak sensing devices which would be susceptible to harmonic distortion induced setpoint drift. To prevent this phenomena, low pass filters were previously installed.

The equipment evaluation shows that safety related equipment will not be impacted by THD during the short duration it will take for an operator to reduce ASD speed to a value which corresponds to less than 5% voltage THD.

It should also be noted that THD generated by the failure of an ASD harmonic filter would result in higher THD levels on the Class 1E buses which share the associated startup transformer (2 SU or 343 SU). This equates to two of PBAPS, Unit 2 and two of PBAPS, Unit 3 Class 1E buses. This arrangement ensures that only one division of safety related equipment per unit is exposed to higher THD levels during the time while the operator is reducing ASD speed.

Question 5:

Given that the harmonic currents generated by the proposed adjustable speed drive's converter inverter are kept within a 5% limit by harmonic filters, will there be any resonant conditions generated which can produce currents greater than what Class 1E electrical equipment is designed.

Response:

The plant electrical distribution system does not employ power factor correction capacitors or very long feeder cables. Therefore, resonant conditions would not be expected. This has been confirmed by the power system harmonic study.

Question 6:

Provide the basis for the IEEE conclusion and recommendation that if voltage distortion is kept within a 5% limit, other equipment subject to the voltage distortion will operate satisfactorily.

Response:

The conclusion and recommendation of IEEE 519 are that if voltage distortion is kept within a 5% limit, other equipment subject to the voltage distortion will operate satisfactorily. Minimal motor and transformer derating may be required if they were to be operated continuously with no greater than 5% THD. The conclusion and recommendation are based on the results of published quantitative analyses using established analytical techniques to determine the effects of harmonics on electrical power, control and metering equipment.

The THD limit of 5% was first included in IEEE 519 in 1981. This limit proved to be adequate and was included without modification 11 years later in the 1992 revision of IEEE 519. The conclusion and recommendation of IEEE 519 are also included in other industry standards such as:

1. IEEE 944 Application and Testing of Uninteruptible Power Supplies for Generating Stations
2. NEMA MG-1 Motors and Generators
3. NEMA PE-1 Uninteruptible Power Supplies
4. Federal Information Processing Standards Publication 94, Guideline on Electrical Power for ADP Installations published by The National Bureau of Standards

Question 7:

At PBAPS, have electrical, instrumentation, and control system equipment associated with or connected to the 4.16 kV or lower voltage Class 1E buses (including equipment's protective systems) been designed to operate satisfactorily with a harmonic voltage of 5% superimposed on the input voltage by operation of the proposed adjustable speed drive.

Response:

It should be noted that the ASD voltage THD contribution is provided in our response to Question 3. At the time of the PBAPS construction, ANSI and NEMA rating structures for electrical power equipment did not include design values for harmonic voltages/currents. More recently, standards preparing organizations, have been addressing the effects of harmonics on electrical power equipment by establishing limits on harmonic currents/voltages. In the absence of such design values, the recommendations of IEEE and NEMA are used to verify the adequacy of installed electrical power equipment to operate in the presence of harmonics. However, for instrumentation and control equipment, it has been the practice for many years to design such equipment to be capable of successful operation when supplied from a power source with no greater than 5% THD.

Question 8:

Define the harmonic voltage/current for which Class 1E electrical equipment is designed.

Response:

Refer to our response to Question 7.

Question 9:

Define the harmonic current that can be developed by the converter-inverter assuming no failures.

Response:

Table 2.2 of Attachment 3 identifies the harmonic injection currents of the ASDs as a function of speed. These harmonic injection currents, together with the startup transformer impedances, are used to calculate the voltage THD at the 13.8 kV bus when assuming harmonic filter failure. Otherwise, with the harmonic filter operational, the harmonic currents flowing through the filter are shunted from the ASD currents resulting in less than 5% THD voltage on the electrical distribution system.

Question 10:

In addition to the harmonic filters, identify other components of the adjustable speed drive (or other system/components) used to limit harmonic current at Class 1E electrical equipment.

Response:

The mean time between failures (MTBF) of the ASD harmonic filters is expected to be several hundred thousand hours. In order to detect a failure or degradation of the filter, an unbalance relay is installed to monitor current through the filter networks. On a current imbalance, which would be indicative of filter degradation or failure, an alarm is generated on the ASD's Video Display Unit (VDU) in the main control room. Any ASD alarm condition also results in a common "ASD Trouble" alarm in the main control room. Upon receipt of the common alarm, the operator can determine the cause by viewing the message on the VDU. A "Harmonic Filter Failure" alarm will display on the VDU for actuation of the unbalance relay. Upon receipt of this alarm, the operator will be directed to reduce ASD speed to reduce distortion levels on the attached electrical system. The power to the current imbalance relay has both a normal and an automatic alternate source. In addition to this alarm, the Class 1E electrical system THD levels will be periodically monitored as specified in the reply to Question 2.

As stated previously, the emergency buses degraded grid protective relays at PBAPS, Units 2 and 3 are peak sensing devices which would be susceptible to harmonic distortion induced setpoint drift. To prevent this phenomena, low pass filters were previously installed.

Question 11:

Have the harmonic filters been designed and sized for the harmonic current generated from the adjustable speed drive as well as the harmonic current from the power supply system for all modes of plant operation.

Response:

Yes. The ASD harmonic filters have been designed and sized based on input from the ASD manufacturer on the harmonic injection currents of the ASDs. The inductors and capacitors for the filters were sized based on 150% of the requirements set by the ASD manufacturer. In addition, PECO Energy provided data on the PBAPS, Unit 2 electrical system configuration, as well as existing THD levels at the site. The adequacy of the filter sizing, including the electrical distribution system induced harmonics, have been verified.

Question 12:

Identify hardware and soft failures that can be anticipated for the adjustable speed drive (or for other system/components used to limit harmonic voltages on class 1E electrical equipment) which will allow harmonic currents greater than the established limit on Class 1E electrical equipment.

Response:

In order for the ASD to cause an increase in its harmonic injection currents, the firing sequence of the Silicon Control Rectifiers (SCRs) in the ASD source bridge must deviate from their normal pattern. As indicated by General Electric in our August 22, 1994 conference call with the NRC, such misfiring would be detected by internal monitoring circuits of the ASD, which would result in an ASD trip.

Question 13:

Describe design, administrative, protection, and/or other provisions that will be implemented to assure that the identified hardware and soft failures will not expose redundant Class 1E electrical equipment to harmonic voltages/currents or other conditions for which they are not designed.

Response:

An harmonic analysis of the PBAPS, Unit 2 electrical system has been performed. This study shows that the Class 1E electrical system can be impacted only during times when the ASD auxiliary buses are supplied by the startup transformers, the ASD is at high speed, and the harmonic filter fails. Under these conditions, procedures will require a reduction in ASD speed to lower THD. Refer to our responses to Questions 4 and 12 for additional discussion.

During a conference call between PECO Energy Company and the U. S. Nuclear Regulatory Commission on August 22, 1994, two additional questions were identified. The following are the questions and responses:

Question 14:

Consider the option of applying an administrative limit such that all the safety related buses will not be connected to the same startup source when reactor power is greater than 60%.

Response:

Regardless of electrical alignment, operational procedures will require the ASD to be reduced to below 50% speed on the detection of a failure of the harmonic filter. This ASD speed ensures that THD levels will be less than 5%.

Question 15:

Justify that THD will have no impact on nonsafety related equipment and controls and that safety related equipment will not be needed to compensate for the effects of nonsafety related equipment failures.

Response:

It is not expected that failure of the harmonic filter and its resultant effect on nonsafety related equipment will induce a plant transient before the time that the operator can reduce the ASD to below 50% speed. This expectation is based on the fact that the non-Class 1E equipment will be exposed to voltage distortions only slightly higher than the accepted 5% limit, and only for a short duration. If this unlikely event were to occur, this could possibly result in a slight increase in the amount of plant transients. However, this slight increase is more than offset by the reduction in the number of plant transients attributable to replacing the existing recirculation pump MG sets with the ASD.

ATTACHMENT 2

SUPPLEMENTAL INFORMATION REGARDING AUGUST 17, 1994 RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION (ASD RAI-3)

In our August 17, 1994 response, PECO Energy Company indicated that the addition of the MCPR-RPT System at PBAPS, Unit 2 constituted a change to the plant licensing basis. While the MCPR-RPT system does represent an addition to the operational flexibility options currently employed at PBAPS, such as Single-Loop Operation (SLO), Feedwater Heaters Out-of-Service (FHOOS), and increased core flow (ICF), it does not constitute a change to the design basis. Those transient events that were previously limiting with respect to core thermal margins remain limiting and continue to be the basis for the cycle specific licensing analyses. Furthermore, the analytical methodology is unaffected. Therefore, the design basis is unchanged.

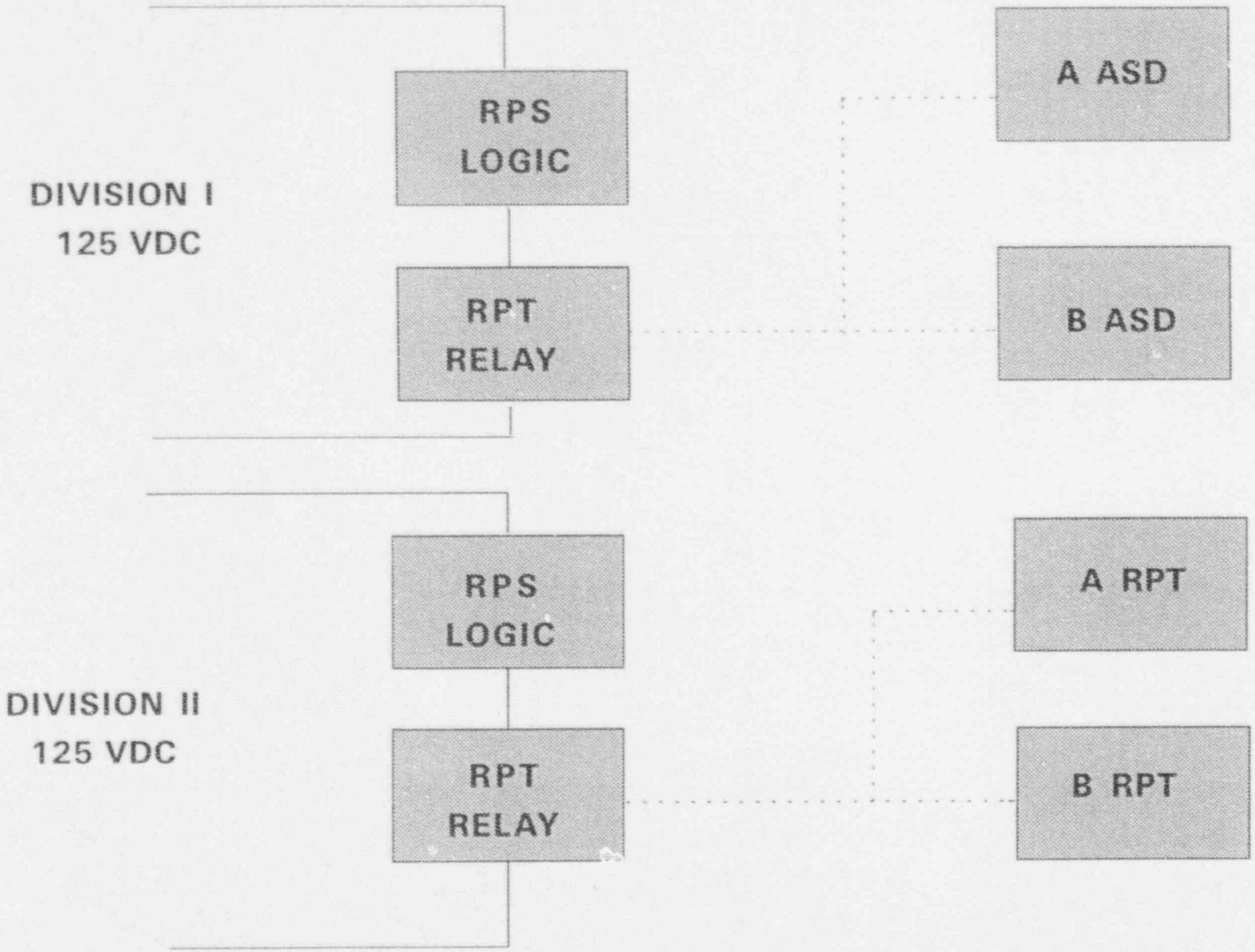
Additionally, PECO Energy Company indicated in our August 17, 1994 response that the addition of the MCPR-RPT System feature would increase the margin to safety. The following is a further clarification of that statement. The recirculation pump trip feature reduces the change in Critical Power Ratio (CPR) during certain transient events. Since the safety limit Minimum Critical Power Ratio (MCPR) is a fixed value, independent of the transient response, this allows for a less restrictive, i.e., lower, operating limit MCPR. PECO Energy Company intends to utilize the lower operating limit MCPR associated with the MCPR-RPT System to enhance plant operations. Thus, the margin of safety associated with the limiting plant transients/conditions is neither increased or decreased. However, the MCPR-RPT System is expected to increase the general level of safety of the plant by reducing the severity of both limiting and non-limiting plant transients.

The MCPR-RPT System is actuated on a turbine trip as sensed by turbine stop valve (TSV) closure, or a generator load rejection as sensed by turbine control valve rapid closure. Both of these events also generate a Reactor Protection System (RPS) scram signal if reactor thermal power is above 30%. For the PBAPS Unit 2 MCPR-RPT System design, the RPS logic relays which provide the scram signal are also used for initiation of the MCPR-RPT System.

The MCPR-RPT System logic is powered from safeguard 125 VDC sources, and the cables are run in separate, rigid steel conduits in order to meet electrical separation requirements. There are two independent trip systems which actuate diverse trip mechanisms in the MCPR-RPT System; one system trips both the RPT breakers, and the other trips both Adjustable Speed Drives (ASDs). Therefore, the MCPR-RPT System is considered highly reliable. Refer to attached block diagram for a representation of the MCPR-RPT System.

If the plant were operating with the limiting fuel bundle at the operating limit MCPR based on an operable MCPR-RPT System, and the limiting plant transient were to occur with a concurrent failure of the MCPR-RPT System, it is conservatively estimated that approximately 0.7% of the fuel rods in the core would experience transition boiling. However, it should be noted that this is a highly unlikely event. For this situation to occur, the core would have to be in a limiting condition (i.e., near the end of cycle with all control rods out), the plant would have to be in the unusual condition of operating with no MCPR margin, and the MCPR-RPT System would have to fail. In addition, the limiting event analysis assumes a worst case failure of the turbine steam bypass system. The probability of these events/conditions occurring simultaneously is very low. Furthermore, should such an event occur, the time period that the limiting fuel rods would be in transition boiling is estimated to be less than a few seconds. Tests conducted on representative BWR fuel rods indicate that transition boiling can be sustained for period up to several hours without cladding failure.

PBAPS RPT LOGIC



ATTACHMENT 3