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SUBJECT: Application for amend to license NPF-21,revising TS to reflect replacement of existing reactor recirculation flow control sys w/adjustable speed drive sys.

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WASHINGTON PUBLIC POWER SUPPLY SYSTEM

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October 26, 1995
GO2-95-228

Docket No. 50-397

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

Gentlemen:

Subject: **WNP-2, OPERATING LICENSE NPF-21 REQUEST FOR AMENDMENT TO TECHNICAL SPECIFICATIONS, REACTOR RECIRCULATION SYSTEM ADJUSTABLE SPEED DRIVE UPGRADE**

References:

1) NRC Information Notice 95-16, March 9, 1995, "Vibration Caused by Increased Recirculation Flow in a Boiling Water Reactor"

2) GE Nuclear Energy, NEDC-32141P, June 1993, "Power Uprate with Extended Load Line Limit Safety Analysis for WNP-2"

3) Letter GO2-95-047, dated March 8, 1995, JV Parrish (SS) to NRC, "Cycle 10 Core Operating Limits Report (COLR)"

4) GE Nuclear Energy, NEDC-32115P, Revision 2, July 1993, "Washington Public Power Supply System Nuclear Project 2 SAFER/GESTR-LOCA Loss-of-Coolant Accident Analysis"

In accordance with the Code of Federal Regulations, Title 10, Parts 50.90 and 2.101, the Supply System hereby submits a request for amendment to the WNP-2 Technical Specifications. This proposed amendment revises the Technical Specifications to reflect the replacement of the existing Reactor Recirculation (RRC) flow control system with an adjustable speed drive (ASD) system.

The RRC system provides recirculation flow through the reactor core during normal operation and has no active safety-related function. The system consists of two parallel recirculation loops within the primary containment but external of the reactor vessel. Each loop includes an electric motor-driven pump, a hydraulically-operated flow control valve, and an analog-hydraulic flow

control system to control the recirculation flow rate. During plant startup and low power operation, the motor-driven RRC pumps are operated at slow speed (25%) and transitioned to fast speed (100%) after reactor power is sufficient to provide enough feedwater subcooling to prevent flow control valve cavitation (19.5%). Two low frequency (15 Hz) motor generator (LFMG) sets supply power for slow speed operation with the two nonsafety-related 6.9 KV AC buses supplying the 60 Hz power for fast speed operation. To improve plant performance and RRC system reliability, the flow control valves and LFMG sets will be deactivated in place and the analog-hydraulic flow control system will be replaced with dual channel variable frequency ASDs and a digital recirculation flow control (RFC) system. The ASDs and RFC system are classified as nonsafety-related.

The ASDs already have been installed onsite, but are not connected, and are located in a separate building outside and adjacent to the turbine building. The ASDs were functionally tested on a 7000 HP motor-generator unit in June 1995, during the annual maintenance and refueling outage. Following approval of this Technical Specification amendment request, the ASDs and the new digital RFC system will be retrofitted to the RRC system to provide variable speed pump operation for system flow control. This design change will be implemented such that there will be no adverse effect on the reactor coolant pressure boundary (RCPB) or operation of the RRC pumps. The RRC flow control valves will be deactivated in place and mechanically blocked open.

Final implementation of the ASD design change, including connection to plant systems and operator training, is scheduled during the Spring 1996 (R-11) Maintenance and Refueling Outage which is currently planned to begin in April 1996. To support this schedule, the Supply System requests that this proposed Technical Specification amendment be issued by March 15, 1996. It is also requested that 60 days be allowed for implementation following the date of issuance. This will provide some outage schedule flexibility. If desired, members of the Supply System and General Electric (GE), Nuclear Energy Division, staffs will meet with the NRC staff in Washington, D.C. after receipt of this submittal to answer questions regarding the ASD design change or this amendment request and to proactively address any potential concerns.

This Technical Specification amendment request is subdivided as follows:

- Appendix A discusses the reasons for the ASD design change and the functional objective and provides a design description.
- Appendix B provides the justification for the change, including a discussion and evaluation of the ASD design change and the proposed changes to the Technical Specifications.
- Appendix C includes the Figures and Tables referenced in Appendices A and B.

- Appendix D provides the Supply System's evaluation of the proposed changes in accordance with 10 CFR 50.92(c).

- Appendix E includes the affected pages of the Technical Specifications with the proposed changes indicated.

The evaluation described in Appendix D concludes that the proposed changes to the WNP-2 Technical Specifications do not involve a significant hazards consideration. In addition, as discussed herein, the proposed changes do not create a potential for a significant change in the types or a significant increase in the amount of any effluents that may be released offsite, nor do the changes involve a significant increase in individual or cumulative occupational radiation exposure. Accordingly, the changes meet the eligibility criteria for a categorical exclusion as set forth in 10 CFR 51.22(c)(9). Therefore, in accordance with 10 CFR 51.22(b), an environmental assessment of the changes is not required.

This Technical Specification amendment request has been reviewed and approved by the WNP-2 Plant Operations Committee and the Supply System Corporate Nuclear Safety Review Board. In accordance with 10 CFR 50.91, the State of Washington has been provided a copy of this letter.

Should you have any questions or desire additional information regarding this matter, please call me or Mr. D.A. Swank at (509) 377-4563.

Sincerely,

for J. V. Parrish (Mail Drop 1023)
Vice President, Nuclear Operations

CDM/ml
Attachments

cc: LJ Callan - NRC RIV
KE Perkins, Jr. - NRC RIV, Walnut Creek Field Office
NS Reynolds - Winston & Strawn
JW Clifford - NRC
DL Williams - BPA/399
NRC Sr. Resident Inspector - 927N
FS Adair - EFSEC

STATE OF WASHINGTON )
)
COUNTY OF BENTON )

Subject: Request for Amendment to TS "Reactor Recirculation System Adjustable Speed Drive Upgrade" including proprietary information.

I, P. R. BEMIS, being duly sworn, subscribe to and say that I am the Director, Regulatory and Industry Affairs, for the WASHINGTON PUBLIC POWER SUPPLY SYSTEM, the applicant herein; that I have the full authority to execute this oath; that I have reviewed the foregoing; and that to the best of my knowledge, information, and belief the statements made in it are true.

This submittal contains proprietary information based on information provided by the General Electric Company in NEDC-32271P, WNP-2 Recirculation Pump Adjustable Speed Drive Licensing Report, Revision 1, Class III, dated July 1995.

Also attached is an affidavit executed by Mr. George B. Stramback, Project Manager, Licensing Services, General Electric Company, dated July 26, 1995, which provides the basis on which it is claimed that the subject report should be withheld from public disclosure under the provisions of 10 CFR 2.790.

The Washington Public Power Supply System treats Table 5, Summary Results for ASD Recirculation System Events: Increase in Reactor Pressure, of the submittal as proprietary information on the basis of statements by its owner. In submitting this information to the NRC, the Supply System requests that the subject report be withheld from public disclosure in accordance with 10 CFR 2.790.

DATE 10/26/95, 1995

P. R. Bemis, Director
Regulatory and Industry Affairs

On this date personally appeared before me P.R. BEMIS, to me known to be the individual who executed the foregoing instrument, and acknowledged that he signed the same as his free act and deed for the uses and purposes herein mentioned.

GIVEN under my hand and seal this 26 day of October 1995.

Notary Public in and for the
STATE OF WASHINGTON

Residing at Kennewick, WA

My Commission Expires 4/28/98

## General Electric Company

## AFFIDAVIT

I, **George B. Stramback**, being duly sworn, depose and state as follows:

(1) I am Project Manager, Licensing Services, General Electric Company ("GE") and have been delegated the function of reviewing the information described in paragraph (2) which is sought to be withheld, and have been authorized to apply for its withholding.

(2) The information sought to be withheld is from Table 9 of the GE proprietary report NEDC-32271P, *WNP-2 Recirculation Pump Adjustable Speed Drive Licensing Report,* Revision 1, Class III (GE Proprietary Information), dated July 1995. The proprietary information is delineated as the entire "retyped" page (Attached) from this report and is identified as *Table 5 Summary of Results for ASD Recirculation System Events: Increase in Reactor Pressure,* (GE Proprietary Information).

(3) In making this application for withholding of proprietary information of which it is the owner, GE relies upon the exemption from disclosure set forth in the Freedom of Information Act ("FOIA"), 5 USC Sec. 552(b)(4), and the Trade Secrets Act, 18 USC Sec. 1905, and NRC regulations 10 CFR 9.17(a)(4), 2.790(a)(4), and 2.790(d)(1) for "trade secrets and commercial or financial information obtained from a person and privileged or confidential" (Exemption 4). The material for which exemption from disclosure is here sought is all "confidential commercial information", and some portions also qualify under the narrower definition of "trade secret", within the meanings assigned to those terms for purposes of FOIA Exemption 4 in, respectively, Critical Mass Energy Project v. Nuclear Regulatory Commission, 975F2d871 (DC Cir. 1992), and Public Citizen Health Research Group v. FDA, 704F2d1280 (DC Cir. 1983).

(4) Some examples of categories of information which fit into the definition of proprietary information are:

a. Information that discloses a process, method, or apparatus, including supporting data and analyses, where prevention of its use by General Electric's competitors without license from General Electric constitutes a competitive economic advantage over other companies;

b. Information which, if used by a competitor, would reduce his expenditure of resources or improve his competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing of a similar product;

c. Information which reveals cost or price information, production capacities, budget levels, or commercial strategies of General Electric, its customers, or its suppliers;

d. Information which reveals aspects of past, present, or future General Electric customer-funded development plans and programs, of potential commercial value to General Electric;

e. Information which discloses patentable subject matter for which it may be desirable to obtain patent protection.

The information sought to be withheld is considered to be proprietary for the reasons set forth in both paragraphs (4)a. and (4)b., above.

(5) The information sought to be withheld is being submitted to NRC in confidence. The information is of a sort customarily held in confidence by GE, and is in fact so held. The information sought to be withheld has, to the best of my knowledge and belief, consistently been held in confidence by GE, no public disclosure has been made, and it is not available in public sources. All disclosures to third parties including any required transmittals to NRC, have been made, or must be made, pursuant to regulatory provisions or proprietary agreements which provide for maintenance of the information in confidence. Its initial designation as proprietary information, and the subsequent steps taken to prevent its unauthorized disclosure, are as set forth in paragraphs (6) and (7) following.

(6) Initial approval of proprietary treatment of a document is made by the manager of the originating component, the person most likely to be acquainted with the value and sensitivity of the information in relation to industry knowledge. Access to such documents within GE is limited on a "need to know" basis.

(7) The procedure for approval of external release of such a document typically requires review by the staff manager, project manager, principal scientist or other equivalent authority, by the manager of the cognizant marketing function (or his delegate), and by the Legal Operation, for technical content, competitive effect, and determination of the accuracy of the proprietary designation. Disclosures outside GE are limited to regulatory bodies, customers, and potential customers, and their agents, suppliers, and licensees, and others with a legitimate need for the information, and then only in accordance with appropriate regulatory provisions or proprietary agreements.

(8) The information identified in paragraph (2), above, is classified as proprietary because it contains detailed sensitivity study results for application of a Recirculation Pump Adjustable Speed Drive (ASD) plant improvement modification which GE has developed. These results also utilized analytical models, methods and

processes, including computer codes, which GE has developed for evaluation of the BWR with ASDs.

The development of this plant modification was achieved at a significant cost, on the order of half a million dollars, to GE.

The development of the evaluation process along with the interpretation and application of the analytical results is derived from the extensive experience database that constitutes a major GE asset.

(9) Public disclosure of the information sought to be withheld is likely to cause substantial harm to GE's competitive position and foreclose or reduce the availability of profit-making opportunities. The information is part of GE's comprehensive BWR safety and technology base, and its commercial value extends beyond the original development cost. The value of the technology base goes beyond the extensive physical database and analytical methodology and includes development of the expertise to determine and apply the appropriate evaluation process. In addition, the technology base includes the value derived from providing analyses done with NRC-approved methods.

The research, development, engineering, analytical and NRC review costs comprise a substantial investment of time and money by GE.

The precise value of the expertise to devise an evaluation process and apply the correct analytical methodology is difficult to quantify, but it clearly is substantial.

GE's competitive advantage will be lost if its competitors are able to use the results of the GE experience to normalize or verify their own process or if they are able to claim an equivalent understanding by demonstrating that they can arrive at the same or similar conclusions.

The value of this information to GE would be lost if the information were disclosed to the public. Making such information available to competitors without their having been required to undertake a similar expenditure of resources would unfairly provide competitors with a windfall, and deprive GE of the opportunity to exercise its competitive advantage to seek an adequate return on its large investment in developing these very valuable analytical tools.

STATE OF CALIFORNIA )
) ss:
COUNTY OF SANTA CLARA )

George B. Stramback, being duly sworn, deposes and says:

That he has read the foregoing affidavit and the matters stated therein are true and correct to the best of his knowledge, information, and belief.

Executed at San Jose, California, this 26th day of July 1995.

George B. Stramback
George B. Stramback
General Electric Company

Subscribed and sworn before me this 26th day of July 1995.

Julie A. Curts
Notary Public, State of California

JULIE A. CURTS
COMM. # 974657
Notary Public — California
SANTA CLARA COUNTY
My Comm. Expires SEP 30, 1996

## APPENDIX A

## ASD DESIGN DESCRIPTION

### REASONS FOR CHANGE

Since initial plant startup, the RRC system flow control valves have not performed as reliably as desired. Flow control valve related events have resulted in 5 reactor scrams or forced shutdowns. Furthermore, the valves restrict operational maneuverability during plant startup due to the potential for cavitation and the avoidance of core instability restriction zones.

Installation of the ASDs and replacement of the existing analog-hydraulic flow control system with the digital control system will allow deactivation of the flow control valves and removal of the associated hydraulic system components from the primary containment drywell and the reactor building. Removal of the hydraulic system components will allow 8 hydraulic fluid line containment penetrations to be capped. This in turn will allow removal of the associated containment isolation valves. Removal of the hydraulic system components also will eliminate the use of Fyrquel hydraulic fluid in the drywell and the potential for Fyrquel (organic) intrusion into the reactor coolant via leakage to the suppression pool.

Application of the ASD design is expected to provide the following benefits:

1. Increased RRC pump motor life. Soft (ramped) starts from 0% to 25% speed afforded by the ASDs and elimination of the 25% to 100% speed transfer will reduce the transient current imposed on the motors.

2. Reduced RRC pump, motor, and piping vibration at high speed low flow conditions by maintaining (blocking) the flow control valves in their full open position. This results in direct improvement in the pump reaction loading and is expected to greatly extend the pump life as well as limit future maintenance on the block (isolation) and flow control valves.

3. Improved operator flow control adjustment capability.

4. Improved power to flow maneuverability by the elimination of the flow control valve cavitation interlock.

5. Lower in-plant radiation exposures for maintenance personnel. The deactivation of the flow control valves and the associated hydraulic actuation equipment and the reduced mechanical stress on the block valves are expected to reduce the exposures related to maintenance of these components. The ASDs and the control system are located outside the turbine building in low radiation zones.

6. Faster reactor heat-up capability for hydrostatic testing following a refueling outage by using the RRC pump heat at speeds <u>between</u> 25% and 100%.

7. Increased pump speed margin beyond the current rated value.

8. Lower maintenance costs by replacement of the existing analog-hydraulic RFC system with a higher reliability dual channel solid-state system with self-testing and diagnostics. The current RRC flow control system is a single channel design.

9. Increased safety margins and fewer surveillance tasks by the capping of the flow control valve hydraulic line containment penetrations and the removal of the associated containment isolation valves.

## FUNCTIONAL OBJECTIVE

The ASDs replace the RRC system flow control valves as the means of varying the recirculation flow rate. While the existing flow control valve design varies the flow rate by throttling the flow, the ASDs will provide variable frequency power to each RRC pump motor to vary the pump speed and thereby the system flow. The ASD system is classified as nonsafety-related. The ASDs are required to drive the RRC pump motors at up to 1871 rpm (62.4 Hz) which is 105% of rated speed. This pump speed corresponds to an ASD output (motor stator) frequency of approximately 63 Hz and a pump horsepower of 9500 HP. To provide adequate margin, the ASDs are designed to provide an output frequency of 66 Hz and a pump horsepower of 11,200 HP as measured at the pump shaft. Table 1 provides a summary of the ASD design parameters.

The ASDs are a solid-state variable frequency power supply design that are capable of delivering the power required by each pump motor for normal operation over an output frequency range of approximately 15 Hz to 63 Hz to enable the pump to operate over the range of 25% to 105% of rated pump speed. The ASDs are a dual channel system and each channel has its own non-redundant but highly reliable microprocessor controller that controls each ASD channel and monitors the ASD operating state. The microprocessor controller initiates alarms to inform the main control room operator when minor failures occur or when an ASD has been tripped due to a major fault. The microprocessor also includes self-test features and provides fault diagnostics and annunciator alarm information to the main control room via a video display terminal (VDT).

The ASDs are capable of starting each RRC pump when reactor pressure in the pump casing is exerting full load on the thrust bearing in the pump motor. The digital frequency control system is designed to control the ASD such that it will automatically provide adequate starting torque for the pump motor. This soft-start capability of the ASD will minimize the temperature rise in the motor during startup.

The ASD digital RFC system is designed to operate the RRC pumps at the speed demanded by the main control room operator and respond as required for startup, normal operation, and transient conditions. The system provides interlocks to assure that the proper conditions are established prior to an RRC pump start and also is designed to limit the maximum pump speed and rate of change of pump speed. To respond to normal operating power demands and to make

adjustments to accommodate single-loop operation, the control room operator has the capability of manually controlling the RRC pump motor speed in both loops in either the ganged (two loop) or individual control modes. The control input signal will originate from a Manual Master Setpoint Station located at the main control room operating panel. This signal is used by the digital control system logic to adjust the frequency output of the ASDs for the desired speed for both pumps or as individually selected. Power to the RRC pump motor will be tripped off or reduced in frequency to runback the pump speed for selected transients or abnormal events. These trips and runbacks are either the same or equivalent to those provided by the existing analog-hydraulic flow control system and provide an equivalent level of protection.

## DESIGN DESCRIPTION

The function of the RRC system is to circulate reactor coolant through the core and provide a means of controlling reactor power by varying the coolant flow rate. The existing system is described in WNP-2 Final Safety Analysis Report (FSAR) Section 5.4 and Appendix H. The RRC system consists of two recirculation loops and currently each loop includes a recirculation pump driven by an induction drive motor that is operated at either 25% or 100% speed, an analog-hydraulic flow control system, a flow control valve for flow control at high reactor power levels, and a LFMG set for 25% pump speed operation. This system will be replaced with a variable frequency ASD and digital flow control system.

Implementation of the ASD design change will deactivate the RRC system flow control valves and associated cavitation protection (interlock), the analog-hydraulic flow control system, and the LFMG sets. In addition, the following related equipment will either be physically removed from the plant or deactivated in place.

1. The flow control valve hydraulic actuators, hydraulic power units (HPUs), and the associated hydraulic lines.

2. The eight hydraulic line containment isolation valves.

3. The flow control valve remote/manual controller.

4. The master controller and automatic turbine demand controls, neutron flux controller, and the associated indication and alarms. (This equipment not currently used at WNP-2.)

The ASD system, shown in Figure 1, provides reliable and efficient control of the RRC system drive flow by using dual-channel solid-state ASD units and digital control electronics to vary the speed of the pump drive motor in each RRC loop. Each ASD is designed with enough margin to supply the power required to operate the drive motor up to a load demand of 11,200 HP at 66 Hz.

The ASD is a redundant Gate Turn-Off (GTO) induction motor drive system that consists of the basic elements shown in Figure 2A for each RRC loop. These elements are:

1. The common power input transformer provides a 6.9 KV source voltage and electrically isolates each drive channel from the other channel.

2. The source current converter rectifier in each channel supplies 6-pulse direct current (DC).

3. The DC link reactor smooths the DC output current to the inverter.

4. The load GTO inverter changes the DC current into variable frequency alternating current (AC) and filters or chops harmonics at low speeds.

5. The filter capacitor banks provide harmonic filtering of the ASD output waveform.

6. The input and output circuit breakers allow each channel to be electrically isolated either manually at the breaker for maintenance or automatically on an ASD fault.

7. The common load output transformer combines both channel outputs into a single 12-pulse AC current which is supplied to the induction motor.

8. The GE-FANUC digital control system consists of redundant programmable microprocessors and input and output modules that vary the frequency of the output AC in response to either manual or automatic demand signals.

9. Each ASD contains two Medium Electronic Module (MEM) units. Each MEM unit is dedicated to an individual ASD Channel Control and consists of plug-in cards in a 2 row x 12 slot module. The MEM central processing unit (CPU) digitally controls the firing of the ASD channel power converter silicon controlled rectifiers (SCRs) and load inverter GTO SCRs for driving the motor. The MEM unit also provides various protective functions for the motor, converter/inverter, bridges, and SCR liquid cooling controls.

The ASDs will be connected between the existing 6.9 KV power supply feeder (RRA/RRB) breakers and the Recirculation Pump Trip (RPT) breakers as shown in Figure 2B. During shutdown and low thermal power operation, the ASDs will be supplied power from the TR-S startup transformer via the nonsafety-related SH-5 and SH-6 buses. After the main generator is connected to the Bonneville Power Administration (BPA) 500 KV transmission system (grid), the SH-5 and SH-6 buses will be transferred from the TR-S transformer to the TR-N2 normal transformer. The nonsafety-related 4.16 KV SM-1, SM-2, and SM-3 buses supply power to the safety-related SM-4, SM-7, and SM-8 buses (not shown on Figure). These buses are fed from a separate winding of the TR-S transformer during shutdown and low power operation and from a separate transformer (TR-N1) after the generator is connected to the grid. Thus, there will not be any direct electrical interface between the ASDs and the safety-related buses.

The existing master controller, flux controller, and flow controller process control modules will be replaced with a digital RFC system (Figure 2A). The functions of the process control modules will be replaced with input/output (I/O) modules operated by a software driven microprocessor CPU in the RFC system. The performance of the digital RFC system can be checked during plant outage maintenance periods by an externally connected "work master" station that can interrogate the system status. No software changes can be made without an authorized software access code that is keyed in at the "work master" station.

The new digital RFC system design will be a manual ganged open loop (no feedback) control system. The flow in both RRC system loops will normally be manually controlled from a single control station with no automatic controls based on flow, neutron flux, or thermal power feedback signals. Figure 3 shows the control system major functions. The operator will set the RRC pump speed from the Manual Master Setpoint Station located at the main control room operating panel. The manual ganged control station provides an ASD speed reference demand signal to the ASDs in both RRC loops. The demand signal adjusts the supply frequency in the two loops which determines the speed of the RRC pump drive motors and in turn controls the recirculation flow rate. The two Individual Loop Setpoint/Bias Stations allow the pump speed in each loop to be separately adjusted. A bias provides an adjustment up to ±5% for each loop flow to allow for loop flow balancing. A VDT will be located in the main control room to provide operating status and alarm information for each of the four ASD channels. Major component group alarms are provided on a conventional back lighted annunciator window. The ASD alarms and shutdowns are shown in Table 2. The MEM logic shuts down the ASD by interrupting the firing signals to the SCRs. Pre-trip signals from the 6.9 KV RRA/RRB breakers, source and load isolation breakers, and RPT breakers shutdown the affected ASD while the breakers are opening to prevent damage to the SCRs. To increase system reliability, the GE-FANUC control system uses redundant power supplies and the ASD control system uses a separate uninterruptible power supply. System reliability is also enhanced by the self-test diagnostics and dual channel design. Since the functions performed by the RFC system are not safety-related, the changes described above improve single channel RFC system reliability without an adverse impact on safety. System failure probabilities of 1.25 E-06 and 4.26 E-06 per system demand were calculated for the RFC system GE-FANUC control logic and the entire ASD system, respectively. These failure probabilities are considered low for nonsafety-related systems and translate to high system reliability.

As described above, the ASD frequency demand reference signal will be set by the operator. However, the GE-FANUC microprocessor conditions or overrides the frequency demand signal for each loop for selected transients and abnormal events using interlocks and limiters. The following Table lists the sensed conditions and associated automatic actions provided by the interlocks and limiters. The ASD automatically runs at the lowest frequency demand of either the limiter signal or the frequency demand setpoint signal.

| *Sensed Condition* | | *Action* |
|---|---|---|
| a. | Rate of speed change demanded is too high in either the increase or decrease direction. | Limit the rate of change until the desired speed setpoint is reached. |
| b. | Frequency demanded is too high. | Limit the frequency to the maximum frequency. |
| c. | One feedwater pump tripped and reactor water level less than or equal to +31.5 inches (Level 4). | Reduce speed to 45%. |
| d. | Reactor water level less than or equal to +13.0 inches (Level 3). | Reduce speed to 25%. |
| e. | Temperature difference between the vessel steam dome and the pump suction is less than 9.9°F. | Reduce speed to 25%. |
| f. | One ASD channel is tripped. | Reduce speed to the load capability of the remaining channel. |

The ASD MEM unit microprocessors also include limiters that control operation of the ASD as shown in Figure 3. The ASD frequency demand limiter has the same effect as Item b above and is redundant to that limiter. The ASD rate of change limiter has the same effect as Item a above. It is redundant with that limiter and is set at a slightly higher value. The ASD also includes a loss of signal limiter that locks the input demand signal at its last value if the control demand signal is lost.

The frequency demand reference signal will be routed from the main control room to the ASD local communication panel via redundant data communication buses. At the local communication panel, redundant Genius I/O modules transmit the speed demand reference signals to the appropriate ASD loop/channel controls. The operator will monitor the performance of the RRC system using the ASD loop/channel indicators, existing system indicators, and the main control room VDT.

Upon initiation of a RFC system limiter or development of an alarm or fault in one of the ASD channels, annunciators alarm in the main control room and control is transferred from ganged control to individual loop control.

The Manual Master Setpoint Station and Individual Loop Setpoint/Bias Station have the following features:

1. In the ganged control mode, the operator sets the frequency (speed) demand reference signal from the Manual Master Setpoint Station for both RRC pumps by operating the "raise" or "lower" pushbuttons.

2. A "bias" control on each Individual Loop Setpoint/Bias Station allows the operator manual adjustment for any imbalances which may exist in the flow between the two RRC loops.

3. In the individual loop control mode, the operator can adjust the frequency demand reference for each RRC pump by operating the "raise" or "lower" pushbuttons on the Individual Loop Setpoint/Bias Stations.

4. While in the ganged mode, the internal individual loop setpoint register in the GE-FANUC microprocessor is continuously updated to allow a bumpless transfer from the ganged to the individual loop mode. If a limiter is actuated, or one ASD channel alarms/faults, or one recirculation loop is not operating, control automatically transfers to the individual loop mode.

5. The following is a description of the meter indicators on the Individual Loop Setpoint/Bias Station:

   - A deviation meter indicating the difference in frequency between the Manual Master Setpoint Station demand and the Individual Loop Setpoint/Bias Station demand. The meter will indicate either a positive or negative frequency deviation depending on whether the Master Setpoint Station demand is higher or lower than the Individual Loop Setpoint/Bias Station demand. If the deviation is greater than the setpoint, the transfer from the individual loop mode to the manual ganged mode is inhibited until the difference is reduced by the operator.

   - An output frequency demand reference meter which indicates the conditioned output signal to the ASD.

   - Actual ASD frequency demanded.

   - The Individual Loop Setpoint/Bias Station is also provided with LED indication that will give immediate indication of any "runback" interlock that has operated. On a runback, the reference speeds of the master and individual loop stations are automatically reset.

6. On startup of a pump, the Individual Loop Setpoint/Bias Station will be in the individual loop mode and set to the minimum speed.

The ASD system is placed in the "Ready" (ready to start-up) mode locally once the source and load circuit breakers are closed. In the "Ready" mode, the control room operator can initiate a "Start" signal and the ASD microprocessor will ramp the ASD to the minimum frequency set by the RFC system frequency demand reference signal. This is referred to as a "soft start" because only a single channel of the ASD is required to provide the "break away" torque and accelerate the RRC pump to 1 to 2 Hz. At this point, the second channel ASD switches into operation such that both channels accelerate the pump to the bottom end of the controller speed range (15 Hz). This design significantly reduces the starting current and motor winding heat-up and also eliminates the 25% to 100% speed transfer transient thereby increasing the induction motor life.

Interlocks assure that the following conditions are established before a RRC pump will start:

1. The ASD is ready for operation.

2. The suction and discharge block valves are greater than 90 percent open.

3. The electrical protection "lock-out" relay is reset.

4. The End-of-Cycle - Recirculation Pump Trip (EOC-RPT) function is reset.

5. The pump motor feeder breakers, RPT breakers, and ASD source and load breakers are racked-in and closed.

6. The Manual Master Setpoint Station in the main control room is set to minimum pump speed demand.

As previously discussed, the control room operator will have the capability of remote/manual speed control of the RRC pump in each recirculation loop either individually or in a ganged manual control mode to respond to normal plant power demands and to make adjustments to accommodate single-loop operation. The speed control range will be from 25% to 105% of rated pump speed which corresponds to a frequency control range of approximately 15 to 63 Hz. The RFC system will limit the rate of change of pump speed as well as maximum pump speed. For the selected transients and abnormal events indicated below, power to the RRC pump motors will be tripped off or reduced in frequency to runback the pump speed. These trips and runbacks are either the same as, or equivalent to, the current RFC system initiated pump trips and flow control valve runbacks.

1. The EOC-RPT is the RRC system safety-related function that trips the RPT breakers (see Figure 2B) for the RRC pump motors in response to a turbine trip and/or generator load rejection event. This logic is unmodified from that provided with the current design.

2. The power supply to the RRC pump motor will be tripped for the following transients or events:

   - Suction or discharge block valves less than 90% open.

   - Pump motor or ASD (both channels in a loop) electrical system protection logic actuation. A single ASD channel fault will not trip a RRC pump motor feeder breaker.

   - High reactor vessel pressure (>1076 psig) or low water level at -50.0 inches (Level 2) due to an Anticipated Transient Without Scram (ATWS). One RPT breaker for each RRC pump is tripped in response to an ATWS. This logic is unmodified from that provided with the current design.

   - ASD output overfrequency.

3. To protect the RRC pump and jet pumps from cavitation, the RRC pump will be runback to minimum speed (25% of rated) in response to the following events:

   - Low differential water temperature (<9.9°F) between the reactor vessel steam dome and RRC pump suction.

   - Reactor vessel low water level at +13.0 inches (Level 3).

4. The RRC pump will be runback to an intermediate speed upon loss of one ASD channel. The final speed will be based on the maximum load a single channel ASD can provide (5500 HP @ 52 Hz).

5. The RRC pump will be runback to 45% of rated speed upon loss of one reactor feedwater pump with a subsequent reactor vessel low water level of + 31.5 inches (Level 4).

A thermal-hydraulic analysis was performed by GE to evaluate operation of the RRC system when controlled by the ASDs. The model used in the analysis assumes that the flow control valve is removed from the system loop and replaced with a spool piece. Although the flow control valves will actually be deactivated in place and mechanically blocked open, the model is conservative since the assumed configuration produces the lowest loop resistance which results in the highest flow and thus, the highest horsepower requirement versus pump speed. The model was calibrated with actual plant performance data at WNP-2 such as reactor power, core flow, core pressure drop, recirculation pump flow, and jet pump flow. The analysis included the standard heat and mass balance calculations, reactor core and other internal pressure drop models, jet pump performance, external loop piping, and RRC pump data. Calculations for the RRC system operating parameters, cavitation characteristics of major components, and thermal-hydraulic parameters of the reactor core and pressure vessel were performed. The analysis of the RRC system operating conditions resulted in the design parameters summarized in Table 1. The 100% case represents the current rated operating conditions. The 105% case represents the new pump operating limit. The 110% case does not represent an operating condition and serves only to guide the selection of design margins.

The ASDs were sized to provide the RRC pump shaft speed/torque requirements for "cold water" operation up to 900 rpm (to support reactor vessel hydrostatic testing during refueling outages) and design water temperature (535°F) operation up to 1960 rpm. The maximum torque at the pump shaft is 30,000 ft-lbs, which corresponds to a pump speed of 1960 rpm. Using this torque, the horsepower requirement at the pump shaft is calculated to be 11,200 HP. The ASD dual channel system can provide an output frequency of 66 Hz (110% of 60 Hz), which corresponds to the required pump speed of 1960 rpm and horsepower of 11,200 HP. Based on the RRC system operating conditions shown in Table 1, the ASD sizing is conservative since it envelopes the analytical results.

## APPENDIX B

## JUSTIFICATION

### BACKGROUND

Analyses were performed by GE to determine if operation of an ASD system had any significant impact on plant equipment upstream or downstream of the ASDs. These analyses incorporated the power uprate analysis (Reference 2) where appropriate. The upstream equipment includes the main generator, the TR-M1, M3, and M4 main step-up transformers (TR-M2 is disconnected and spared in place), the TR-N1 and N2 normal auxiliary power transformers, the TR-S startup auxiliary power transformer, site switchyard equipment, and the BPA 500 KV and 230 KV grid. The interface between the onsite and offsite electrical power distribution systems is described in FSAR Sections 8.1 and 8.2. The downstream equipment includes the RPT breakers, the RRC pumps and drive motors, the RRC system piping, and the reactor internals. GE also performed evaluations to determine the impact of the ASDs on control system instrument setpoints, pump trips, cable separation, and credible Boiling Water Reactor (BWR) transients and accidents. The evaluations are discussed in more detail in the following sections, but as a preface, it is necessary to describe some ASD design features in more detail to explain the equipment concerns that have been evaluated.

The ASD design shown schematically in Figure 2A uses solid-state electronics, including diodes, transistors, and SCRs, to change a constant frequency and AC voltage source input to a variable frequency and AC voltage output. This is accomplished by using an AC to DC rectifier followed by a DC link and then a DC to AC inverter. The AC to DC rectifier has an arrangement of SCRs for the positive and negative portions of each of the three phases of the input AC sine wave. One polarity inversion (commutation) is needed for each sine wave cycle to rectify the AC power to DC. It is known that each commutation produces stray harmonics that can be injected back into the source AC bus. Therefore, it was necessary to evaluate these harmonics for their effect on the supply grid.

Power between the rectifier and the inverter sections of the ASD is transferred by means of a DC link. This link acts as a power bridge between the two sections to smooth the DC current to the inverter. The large DC link inductor limits the fault current to the inverter so that misfiring of the inverter power devices does not result in a shutdown.

SCRs are also used in the inverter to convert the DC signal to a variable frequency AC signal. The inverter produces harmonics that can be fed to the RRC pump motor. If the motor is not specifically designed for the ASD application, these harmonics can increase motor heating and may produce mechanical fatigue of the motor shaft, coupling, or frame. Filter capacitors are applied across the ASD output to filter the harmonics and avoid derating the motor due to harmonic heating. However, these filters are in parallel with the motor inductance and create an inductance-capacitance (L-C) circuit with a resonance frequency that can be excited by the ASD harmonics. If this resonance frequency is present, harmonic currents can be amplified.

To eliminate this concern the inverter uses GTO SCRs to switch current on or off at appropriate times during a cycle. This allows the inverter current waveform to be notched or chopped in specific patterns to eliminate selected harmonic currents. During acceleration, deceleration, and continuous operation on or through these resonant conditions the ASD control system turns the GTOs on or off at the appropriate time to minimize the harmonic currents.

Although the harmonics are minimized by the GTOs, it was necessary to evaluate the influence that the harmonics could have on the RRC system equipment. The two areas of concern were motor heating due to the harmonics and the effect of the pulsations in the motor air-gap torque since the torque pulsations could excite a rotor natural frequency and cause a fatigue failure. In addition, since the RRC pump, motor, and system piping are connected to the reactor vessel nozzles and suspended from hangers, there is a potential for the torque pulsations to be transmitted from the motor to the safety-related RCPB equipment and excite a natural frequency of that equipment. Thus, the effect of torque pulsations on the RCPB equipment was also evaluated.

As previously described, the ASD design changes the RFC system from a 15 Hz and 60 Hz two-speed RRC pump motor drive system to a 15 Hz to 63 Hz variable speed motor drive system. The 3 Hz (89 rpm) speed increase above the rated pump speed of 60 Hz (1,782 rpm) and the change to variable speed operation required evaluation for their impact on the pump, motor, system piping, and reactor internals. Furthermore, the change to variable speed operation also affects RPT breaker performance and the RPT function because the RPT breakers (3A, 3B, 4A, and 4B) are located between the ASDs and the pump motors. All four RPT breakers are tripped on a generator load rejection with turbine trip signal (EOC-RPT function). Two of the breakers (3A and 3B), one breaker for each pump, are tripped on ATWS signals (high reactor pressure or low water level). Breaker performance is usually characterized in terms of the number of cycles of the power supply that are needed to open the breaker and extinguish the arc. In this case, RPT breaker arc suppression performance is specified as less than or equal to 5 cycles of the power supply. Given the current non-variable 60 Hz power supply for the RRC pump motors at reactor power levels greater than or equal to 30%, the arc suppression time is fixed at less than or equal to 83.3 milliseconds. Since the ASDs vary the frequency of the power supplied to the motor, the arc suppression time will vary inversely with the supplied frequency. For example, the arc suppression time at 63 Hz would be 79.4 milliseconds [(60 Hz/63 Hz) x 83.3 milliseconds] and 100 milliseconds at 50 Hz [(60 Hz/50 Hz) x 83.3 milliseconds]. Since the safety analyses allow WNP-2 to operate at full power for a range of core flows (FSAR Section 4.4), the effect of this variation in breaker arc suppression time on the transient and accident analyses required evaluation.

## POWER SUPPLY GRID HARMONICS ANALYSIS

The power supply grid was analyzed to determine if the ASD rectifier harmonics would impact the buses that supply power to safety-related equipment. The power supply grid connections are shown schematically in Figure 2B. The 4.16 KV SM-1, SM-2, and SM-3 buses are not safety-related but supply power to safety-related buses SM-4, SM-7, and SM-8 (not shown on Figure). The nonsafety-related 6.9 KV SH-5 and SH-6 buses are the power supply for the ASDs. The results of the analysis are shown in the following two tables "% Distortion in Startup Mode (Connected to TR-S)" and "% Distortion in Generation Mode (Connected to TR-N2)." The channel modes refer to the channels of the two ASDs that are operating. For example, A-AB is Channel A in Loop A with Channels A&B in Loop B; AB is Channel A&B in one loop with the other loop shutdown (i.e., single loop operation).

The results of the analysis show that the highest voltage total harmonic distortion (THD V) occurs on the SH-5 and SH-6 buses in startup mode (connected to TR-S) and is expected to be less than 9.9% at full load. The highest current distortion (THD I) occurs in the TR-S transformer X winding in startup mode and is expected to be less than 23.8% when operating one channel in each loop (A-A or B-B). Since the safety-related buses and SH-5 and SH-6 buses are connected to separate windings of the TR-S transformer, there is no direct electrical interface. The highest voltage distortion on the safety-related buses is calculated to be less than 0.5% at full load when using the TR-S startup transformer. However, the normal configuration for full load connects the SH-5 and SH-6 buses to the TR-N2 transformer with the safety-related buses being connected to the TR-N1 transformer. Thus, the safety-related buses are further isolated from the SH-5 and SH-6 buses and the distortion is calculated to be less than 0.2% during normal plant operation.

Onsite operational testing of the ASDs was performed in June 1995 (during a plant outage). The ASDs were connected to a 7000 HP motor-generator unit and tested to verify proper operation during various speed and loading combinations. During the testing, voltage total harmonic distortion (THD) was monitored at SH-6 (safety-related SM-7 bus power supply) and SM-1 (ASD power supply) with the plant connected to the TR-S startup transformer. With all four channels of the ASDs operating at approximately 30% load, the highest voltage THD was 5.2% as measured at SH-6, with a corresponding value of 0.7% measured at SM-1. These actual measured THD values are higher than those listed in the first Table (Connected to TR-S) for comparable load due to the design and size differences between the test motor and the RRC pump motor. In general, the measured THD values increased with increasing ASD load and exhibited the same decreasing rate of change (slope) with increasing ASD load characteristic as the analysis results. Thus, the measured values indicate that the harmonics will be acceptable when the ASDs are connected to the RRC pump motor since the voltage THD measured at the SM-1 bus is significantly lower than that measured at SH-6 and the THD at SM-1 is well within the IEEE-519 industry standard of $\leq 5\%$. Therefore, based on analysis and testing completed to date, the ASD harmonics will not have a significant impact on the safety-related equipment power supplies. The Supply System will monitor the THD again during initial ASD operation following connection to the RRC pumps to confirm that the harmonics are acceptable.

## Analysis Results - % Distortion in Startup Mode (Connected to TR-S)

| CHAN-NEL MODE | LOAD % | THD V SH5/SH6 | THD V SM1 | THD V SM2 | THD V SM3 | THD V 230 Kv Bus | THD I TRS-X | THD I TRS-Y | THD I TRS-H |
|---|---|---|---|---|---|---|---|---|---|
| AB-AB | 100 | 9.9 | 0.5 | 0.5 | 0.5 | 0.8 | 19.4 | 1.4 | 5.4 |
| | 20 | 2.5 | 0.1 | 0.1 | 0.1 | 0.2 | 4.1 | 0.3 | 1.1 |
| A-AB or B-AB | 80 | 7.5 | 0.4 | 0.4 | 0.4 | 0.6 | 16.7 | 1.2 | 4.7 |
| | 20 | 2.1 | 0.1 | 0.1 | 0.1 | 0.2 | 4.2 | 0.3 | 1.2 |
| A-A or B-B | 80 | 8.2 | 0.4 | 0.4 | 0.4 | 0.7 | 23.8 | 1.7 | 6.6 |
| | 20 | 2.1 | 0.1 | 0.1 | 0.1 | 0.2 | 5.1 | 0.4 | 0.4 |
| AB | 100 | 4.9 | 0.2 | 0.2 | 0.2 | 0.4 | 9.4 | 0.7 | 2.6 |
| | 20 | 1.2 | 0.1 | 0.1 | 0.1 | 0.1 | 2.0 | 0.1 | 0.6 |
| A or B | 80 | 4.1 | 0.2 | 0.2 | 0.2 | 0.4 | 11.9 | 0.8 | 3.3 |
| | 20 | 1.0 | 0.1 | 0.1 | 0.1 | 0.1 | 2.6 | 0.2 | 0.7 |

## Analysis Results - % Distortion in Generation Mode (Connected to TR-N2)

| CHAN-NEL MODE | LOAD % | THD V SH5/SH6 | THD V SM1 | THD V SM2 | THD V SM3 | THD V TR-M1&N1 | THD I TR-N2 | THD I TR-N1 (Pri) | THD I TR-M |
|---|---|---|---|---|---|---|---|---|---|
| AB-AB | 100 | 8.2 | 0.2 | 0.2 | 0.2 | 0.3 | 14.3 | 0.2 | 0.1 |
| | 20 | 2.1 | 0.1 | 0.1 | 0.1 | 0.1 | 3.1 | 0.1 | 0.0 |
| A-AB or B-AB | 80 | 6.2 | 0.2 | 0.2 | 0.2 | 0.2 | 12.7 | 0.2 | 0.1 |
| | 20 | 1.8 | 0.1 | 0.0 | 0.0 | 0.1 | 3.2 | 0.1 | 0.0 |
| A-A or B-B | 80 | 6.9 | 0.2 | 0.2 | 0.2 | 0.2 | 18.1 | 0.3 | 0.1 |
| | 20 | 1.7 | 0.0 | 0.0 | 0.0 | 0.1 | 3.9 | 0.1 | 0.0 |
| AB | 100 | 4.1 | 0.1 | 0.1 | 0.1 | 0.1 | 7.2 | 0.1 | 0.0 |
| | 20 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.6 | 0.0 | 0.0 |
| A or B | 80 | 3.4 | 0.1 | 0.1 | 0.1 | 0.1 | 9.0 | 0.1 | 0.1 |
| | 20 | 0.9 | 0.0 | 0.0 | 0.0 | 0.0 | 2.0 | 0.0 | 0.0 |

## CABLE SEPARATION ANALYSIS

Harmonics introduced into the 4.16 KV SM-1, SM-2, and SM-3 buses and the 6.9 KV SH-5 and SH-6 buses by the ASDs could induce electrical noise into plant control and monitoring circuits if sufficient physical separation is not maintained between the plant power circuits and the plant control and monitoring circuits.

WNP-2 design specifications establish the requirements for cable routing and electrical separation and are based on proven industry standards and plant specific experience. The power system (i.e., 480 V, 4.16 KV, and 6.9 KV) is separated from low voltage signal systems (i.e., analog, thermocouple, strain gauge, operational amplifier, etc.) and low voltage control systems (relay logic). Power cables and low voltage control cables are routed in open or covered cable trays and rigid ferrous conduits specifically designated for the type of cable. Low voltage signal cables are routed in specifically designated covered cable trays and rigid ferrous conduits. These design requirements were applied to the 6.9 KV and 4.16 KV power and control cabling installed in and around the new ASD building. These requirements will also be used for installing the ASD power, control, and monitoring cables within the confines of the main control room, power generation control center (PGCC), reactor containment area, reactor auxiliary buildings, and the main turbine generator building. There are no 6.9 KV or 4.16 KV power cables in the main control room or the PGCC panel areas.

At the 6.9 KV and 4.16 KV power level, most of the new power cabling associated with the ASD will be located outside the main turbine generator building in the confines of the ASD input/output power transformers and within the air conditioned ASD building that houses the solid state variable frequency drive units. The new ASD building is located outside of the turbine building and has no cable trays in areas associated with Class 1E safeguards systems or balance of plant control systems critical to power generation. Low voltage control, diagnostic, alarm, and trip signals originating at the ASD drive units and the ASD local communications cabinet will be run in twisted shielded pair wiring within rigid ferrous conduit to assure immunity to electromagnetic interference (EMI). In addition to the cable routing and electrical separation design requirements described above, the power cables between the ASDs and the RRC pump motors will be shielded to minimize EMI emissions.

## ASD OUTPUT HARMONICS ANALYSIS

The effect of the ASD harmonics on the RRC pump motor and RCPB equipment was evaluated because the ASD does not produce a smooth current or voltage sine wave, instead it produces a wave that contains a multiple of harmonics of the fundamental electrical line frequency. These harmonics in turn produce harmonic heating of the motor stator and pulsations in the motor air-gap torque which are added to the steady-state shaft torque. Consequently, it was necessary to analyze the impact of the ASD characteristic on the affected RRC system components which include the motor stator, motor-pump rotating assembly, the pump casing, and the attached piping. The results of the analysis of these components show that the additional stresses caused by the ASD are not significant and that the additional motor heating will not significantly affect motor life.

A torsional evaluation of the RRC pump motor rotor established the electrically induced air-gap torque pulsations due to the ASD application over the entire speed range. The torsional response in the rotor shaft was investigated at all significant critical operating speed points where the ASD torque pulsation disturbance coincides with one of the torsional natural frequencies of the rotor. The rotor shaft torsional responses were also evaluated for torque pulsations at the impeller due to blade-passing pressure disturbances. The study shows that the magnitude of the resulting pulsations was low enough that no significant vibration would occur in the pump or pump motor rotors. It was determined that the high inertia of the motor rotor acts as a filter to help attenuate the resonance mode excitations caused by the electrically induced torque pulsations.

An evaluation of the RRC system stationary components established the vibrational response of the motor, pump stand, and pump casing due to the air-gap torque pulsations and blade-passing pressure disturbances. All significant operating speed points at which air-gap torque or pressure disturbances coincide with natural frequencies of the stationary system were evaluated with a comprehensive three-dimensional finite element model. At the limiting critical speed points investigated, no significant responses were observed. The motor was further evaluated for thermal and voltage stresses, thermomechanical forces, electromechanical forces, insulation capability, and mechanical capability. Based on this evaluation, it was concluded that the ASD harmonics will not have a significant impact on motor capability or life.

The RRC piping loops were modeled and an analysis performed to determine the impact of the ASD on the stress and displacement of the structure. The model was subjected to the torsional time history developed from the pump torsional evaluation. The results show that the maximum displacement during the torque pulsations does not violate snubber deadbands or exceed imposed space restrictions. The maximum steady-state vibrational stress was less than the 10,000 psi allowable.

The RRC piping configuration was also subjected to a steady-state sinusoidal forcing function of varying frequencies over the speed range to simulate an unbalance in the rotating mass of the RRC pump and motor assembly. The effect of the snubbers was not included in this analysis since they are inactive in low level vibration displacement at steady-state. The maximum resulting displacement occurred at a snubber connection to the tee on the RHR system return branch line. The highest stress point occurred at the pump suction elbow. Based on the analysis, the maximum piping displacement remained within the snubber deadband and the maximum steady-state vibrational stress was less than the 10,000 psi allowable.

Due to the reliability of the ASD equipment, it is unlikely that a fault could occur that would increase the output harmonic levels without causing a trip of the ASD itself. However, in the unlikely event that such a fault should occur, monitoring equipment exists to detect any excessive harmonic induced vibration. The RRC pump and motor at WNP-2 are monitored for vibration as follows :

*Sensors*

| | |
|---|---|
| Pump Shaft : | Proximity Probes (X/Y* - on seal cover, lower coupling half) |
| Top of Motor : | Thrust Probe in Z direction, RPM and phase angle sensors<br>Accelerometer (X/Y/Z* - block on motor upper bearing oil reservoir casing) |
| Bottom of Motor : | Accelerometer (X/Y/Z* - block near lower guide bearing) |
| Pump : | Accelerometer (X/Y/Z* - block mounted on a pump casing lifting eye) |
| | * directions are X/Y - in direction of flow and perpendicular to flow, Z is vertical to the X/Y plane |

The sensor signals are fed through a primary containment penetration to a Bentley-Nevada vibration monitoring system located in the reactor building on the 522 foot elevation. If the sensors detect a high vibration, a Bentley-Nevada system module sends an alarm signal to an annunciator in the main control room. The vibration sensors also provide RRC pump and motor vibration and alarm status information to a computer monitor used for system calibration and testing.

## SPEED VARIATION EFFECTS ANALYSIS

Since the ASDs change the RFC system from a 15 Hz and 60 Hz two-speed system to a 15 Hz to 63 Hz variable speed system, the 3 Hz increase above rated speed and the change to variable speed operation needed to be evaluated for their impact on the RRC pump, motor, system piping, and reactor internals. The RRC pump and motor were designed for 60 Hz operation, so the 15 Hz to 60 Hz operating range was within their design basis. The pump, motor, and piping evaluations also considered a 5% speed increase and the effects of the increased system operating temperature, pressure, and flow on stress, bearing loads, and the potential for stress corrosion cracking. Based on these evaluations, it was concluded that there is sufficient design margin available for operation up to 63 Hz. Although not quantified, variable speed operation is expected to significantly reduce the loads on the pump at low flow rates since the existing flow control valve design requires throttling the pump at 100% speed.

The results of past reactor vessel internals vibration tests were also evaluated to determine which components had natural frequencies in the ASD frequency range that might be adversely affected by variable speed operation of the RRC pump. The vibration tests examined included those conducted at WNP-2, at prototype BWR-5 plants, and at other plants which had reactor vessel internals identical or similar to WNP-2. This assessment identified the following critical reactor internal components which were subsequently analyzed in detail:

1. Jet Pumps
2. Shroud-Separator
3. Feedwater Sparger
4. Liquid Control/ΔP Line
5. Control Rod Guide Tube
6. Core Spray Line
7. In-Core Guide Tube
8. LPCI Coupling
9. Fuel
10. Steam Dryer
11. Jet Pump Sensing Lines.

A detailed assessment of these components concluded that with the exception of the jet pump sensing lines the evaluated internals would withstand flow induced vibrations from the ASDs without exceeding any acceptance criteria. Vibration tests were performed on the jet pump sensing lines to determine the natural frequencies and stresses that could occur as a result of ASD variable speed operation. A sinusoidal sweep frequency test was performed to determine the jet pump sensing line resonant frequencies. Dwell tests were performed for 3 minutes at each natural frequency to measure their response. Natural frequencies were detected between 129 Hz and 160 Hz for the sensing lines and high stresses were found at the bracket welds which could reach 88,000 psi. The current allowable steady-state vibrational stress is 10,000 psi.

These results indicate that stresses in the bracket welds for the 20 jet pump sensing lines are high enough at resonant frequencies that mitigation devices should be considered before operating the ASDs above 15 Hz. The 15 Hz frequency value corresponds to low speed in the current two-speed mode of RRC pump operation. Installation of the mitigation devices would change the natural frequency and prevent bracket and/or sensing line failure. Loss of a sensing line would cause the affected jet pump to indicate an incorrect diffuser-to-lower plenum differential pressure. This condition would be detected within 24 hours when pressure measurements are taken for jet pump integrity verification in accordance with Technical Specification Surveillance Requirements 4.4.1.2.1 and 4.4.1.2.2. The erroneous reading would require the plant be in hot shutdown within 12 hours in accordance with Technical Specification 3.4.1.2.

Based on the above finding, GE recommended that vibration mitigation devices (clamps) be installed on each jet pump sensing line before ASD operation above 15 Hz. It is the Supply System's intent to follow the GE recommendation to allow unrestricted ASD variable speed operation following implementation during the R-11 outage. However, as a minimum, each jet pump sensing line will be clamped sufficiently prior to initial ASD operation above 15 Hz to provide assurance that the RRC pumps can be operated at variable speed up to 1800 rpm (60 Hz ASD output frequency) for 3 years without any sensing line failures. The appropriate ASD operating limits will be imposed by plant operating procedures and ASD limiter setpoints. Additional clamps will be installed as necessary within 3 years to allow continued plant operation using the ASDs.

Subsequent to the GE recommendation for vibration mitigation devices, the Supply System discovered a crack in the wall of jet pump sensing line #18 adjacent to and at the top of the weld joining the sensing line to the highest bracket on the jet pump diffuser. Analysis concluded that crack propagation was unlikely and continued plant operation was justified in the current two-speed mode of RRC pump operation. To allow plant operation following ASD implementation, the Supply System will install sufficient clamping on jet pump sensing line #18 prior to initial ASD operation above 15 Hz to prevent crack propagation during pump variable speed operation within the design limits.

Increased RRC system noise and vibration have been reported by some BWR 3 and 4 plants when they have increased RRC pump speed (Reference 1). The plants reporting this condition have 5 blade RRC pump impellers, 251 inch reactor vessels, and RFC systems using motor-fluid-coupler generator sets that vary RRC pump speed. WNP-2 is a BWR 5 plant with 5 blade RRC pump impellers, a 251 inch vessel, and following ASD installation, the pump speed will be variable. As a result, analyses were performed for WNP-2 to determine the effects of increased pump speed and harmonics induced vibration on the RRC system pump, motor, and piping and the reactor internal components. Based on the results of these analyses, RRC system and reactor internals vibration are expected to remain within acceptable limits during variable and increased pump speed operation following ASD installation. As discussed above, specific action will be taken to mitigate potential increases in jet pump sensing line vibration. In addition, the Supply System will monitor large bore and small bore RRC system piping during initial ASD operation to assure vibration levels are acceptable. Administrative operating limits will be established if excessive vibration is detected.

## SETPOINT ANALYSIS

The RFC system does not perform any active safety-related functions. However, the system does have interlocks and setpoints that are intended to maintain plant availability or prevent damage to equipment during transients or abnormal events. These functions were identified in in Appendix A.

Setpoints quantify the abnormal operating condition values for which the RRC pumps should be tripped or the speed should be runback. The pump speed runback feature performs the same function as the existing automatic transfer from fast to slow speed. Most of the setpoints for the trip and runback features are determined from parameters and instruments in other systems, such as the loss of a feedwater pump signal, reactor vessel pressure and water level, or vessel steam dome temperature. These parameters are not affected by the RRC system and, therefore, would not change because of the ASDs. The only setpoint parameter for pump speed runback that is within the RRC system is RRC pump suction water temperature. The average suction temperature is compared with the vessel steam dome temperature to identify when the available pump net positive suction head (NPSH) is marginally low. The pump speed is runback when the differential temperature reaches 9.9°F (15 second time delay) to avoid pump cavitation. The ASDs will not affect the pump suction temperature measurement or the steam dome temperature (not an RRC system parameter) and, therefore, will not affect the setpoint. Other than the RPT function, which will be discussed in the Transient section of this Appendix, there are only two RRC system related conditions that trip the RRC pumps. They are the suction or discharge valves <90% open and the pump motor protection logic which trips the pumps to prevent equipment damage. The ASDs will have no impact on the function of either of these trips.

## EMI ANALYSIS

The RFC system GE-FANUC digital equipment is to be installed in the main control room. The GE-FANUC equipment is designed to perform in industrial environments and, as such, the equipment was tested and meets the following test standards for EMI emissions and immunity:

- FCC Radiated and Conducted Line Noise, FCC Rule, Part 15, Subpart J, for Class A computing devices
- Electrostatic Discharge (ESD), MIL-STD 883
- Fast Transient Burst, IEC 801-4
- Radio Frequency (RF) Susceptance, MIL STD 461B, Sections CS01 and CS02
- Surge Withstand, ANSI/IEEE 37.90a.

A baseline survey of the WNP-2 main control room environment was conducted with the reactor at power using MIL-STD 461 and 462 as the bases to determine the levels of EMI present. A review of the survey results confirmed that the GE-FANUC equipment will not be susceptible to conducted and radiated noise over the entire signal spectra from 10 Hz to 100 Mhz (with margins of 26 and 48 dB, respectively). The review also showed that the equipment will have no impact on the electromagnetic environment in the main control room.

Outside of the main control room, ASD low voltage control, diagnostic, alarm, and trip signals will be run in twisted shielded pair wiring within rigid ferrous conduit to resist the effects of EMI. To minimize the effects of EMI emissions from the ASDs on safety-related and balance of plant control systems, the ASDs are located in a separate building outside of the turbine building and the power cables to the RRC pump motors will be shielded and routed in accordance with the previously described cable routing and electrical separation criteria. Furthermore, based on the following transient analyses, a potential EMI related malfunction or failure of ASD or RFC equipment will not significantly impact the plant safety analysis.

## TRANSIENT ANALYSES

To address all of the credible transient events, the initial operating license of a BWR plant is based on the analyses from a spectrum of FSAR Chapter 15 transient events. Plant disturbances caused by equipment malfunction, a single equipment failure, or an operator error were investigated according to the type of initiating event. Each event was assigned to a category of similar events. In this manner, the most severe transient events relative to the critical power ratio (CPR) and reactor coolant system pressure were identified. The relative and absolute consequences of the events are generally plant specific and often fuel cycle specific as well. Most of the events result in fairly mild plant disturbances and only a few events are severe enough to be potentially limiting. The most limiting transient can always be expected to come from the same selected group of transients. It should be noted that the current cycle specific analysis as documented in the WNP-2 Core Operating Limits Report (COLR) identified the Turbine Trip without Bypass event as the limiting transient.

The following transient analyses address the effects of anticipated process disturbances. Postulated ASD system component failures were examined to determine their consequences and to evaluate the plant's capability to control or accommodate such failures. The events that could result from the postulated failures were analyzed and include anticipated operational occurrences, off-design abnormal transients that induce system operating condition disturbances, and postulated accidents of low probability. The anticipated operational occurrences involving the RRC system can be put into two general categories: flow decrease and flow increase. Within FSAR Chapter 15, the spectrum of postulated initiating events is divided into categories based upon the type of disturbance and the expected frequency of the initiating occurrence. The postulated initiating events primarily affected by the RFC system are "Decrease in Reactor Core Coolant Flow Rate" which covers flow decrease and "Reactivity and Power Distribution Anomalies" which covers flow increase. Other postulated initiating events affected by the RFC system are "Decrease in Reactor Coolant Temperature" which covers increased core inlet subcooling coupled with vessel pressurization and "Increase in Reactor Pressure" which covers vessel pressurization. Previous analyses (Reference 2) have shown the Generator Load Rejection with Turbine Trip and Bypass Failure event to be the most limiting anticipated operational occurrence of these latter two categories of initiating events. Thus, only the Generator Load Rejection with Turbine Trip event is considered further for the latter two categories. This event is affected by the ASD frequency effect on the RPT breaker arc suppression times.

The results of the flow increase and flow decrease transient analyses are summarized in Table 3. For comparison, Table 4 provides a summary of the previous FSAR analyses results. The overall system response is governed by the inertia of the RRC pump and motor as opposed to the inertia of the existing flow control valve (i.e., a larger inertia leads to a slower response). These effects can be seen in the data for maximum neutron flux and maximum core average surface heat flux.

The results of the Generator Load Rejection with Turbine Trip transient analyses are summarized in Table 5. The results of the previous analyses from Reference 2 are also included in the Table for comparison. The ASDs affect the event indirectly through the RPT breaker response. As previously discussed, the RPT breaker opening action for electric arc suppression varies inversely with the ASD output frequency. As the core flow increases along a constant power line, so does the RRC pump speed as well as the ASD output frequency. Thus, the RPT arc suppression times will decrease as the core flow increases. Conversely, as core flow decreases, pump speed and ASD output frequency also decrease resulting in an increase in RPT arc suppression times. For the constant rated power line, the RRC pump speed at the low flow condition is approximately 1580 rpm (88% rated core flow) while the pump speed at the high flow condition is approximately 1870 rpm (106% rated core flow). Over this core flow range (or pump speed range) the total RPT delay time, including turbine governor valve (TGV) fast closure time, will increase from approximately 185 milliseconds at 106% core flow to approximately 200 milliseconds at 88% core flow. For reference, the total RPT delay time for the current RFC system using the flow control valves is 190 milliseconds.

The above events and analyses are discussed in detail below.

## Increase in Reactor Pressure

As described in FSAR Chapter 15, anticipated operational occurrences included in this category are those that result directly in a significant increase of the reactor and nuclear system pressure. Of this group of events, the Generator Load Rejection with Turbine Trip and Bypass Failure is typically the most limiting and it also has an interface with the RPT function. The input data applicable to this event is presented in Reference 2. Also, as indicated, the event assumes a failure of the main steam bypass around the turbine to the main condenser which is the most limiting single failure. A TGV trip scram and RPT are designed to satisfy the single failure criterion.

The Generator Load Rejection with Turbine Trip event is initiated by a main turbine digital electrohydraulic control (DEH) system power to load imbalance device which detects a generator electrical load rejection before a measurable turbine speed change takes place. The load imbalance device trip initiates a TGV fast closure. The TGV fast closure causes the reactor pressure to rise rapidly, causing a void collapse which increases neutron flux and produces an increase in reactor power. At the onset of the event, a TGV trip scram is automatically initiated to mitigate the increase in neutron flux and reactor power. At approximately 185 to 200 milliseconds after initiation of the event (depending on pump speed), the RPT circuit de-energizes power to the RRC pump motors. As shown in Table 5, the inclusion of the variable RPT delay in the transient analysis is not significant because the relative change of the RPT delay at 88% core flow or 106% core flow from the previous analysis assumption of 190 milliseconds is small.

**Decrease in Reactor Core Coolant Flow Rate and Reactivity**

As described in FSAR Chapter 15, anticipated operational occurrences included in this category are those that cause a decrease in core coolant flow. Disturbances to the RRC system that produce a reduction in pump flow (drive flow) result in a reduction of reactor power due to the negative reactivity generated by an increase in the core void fraction. The fuel surface heat flux decreases at a slower rate than the flow due to the relatively slower rate at which the stored energy in the fuel is conducted out of the fuel pin. However, the impact on the CPR is still very mild, even for rapid flow decreases caused by the trip of a pump.

An increase in reactor vessel downcomer water level is usually associated with a rapid core flow decrease. The level increase is caused by the decrease in flow out of the downcomer (through the jet pump) without a corresponding decrease in flow into the downcomer from feedwater and separator flow. If the level transient is mild enough, the feedwater control system will return the level to normal at a new (lower) steady-state power and flow condition. If the level transient is more severe (e.g., due to the trip of both RRC pumps), the high water level +54.5 inch (Level 8) trip setpoint may be reached causing a trip of both reactor feedwater (RFW) pumps and also the main turbine. The events evaluated under this category are discussed in the following four sections. The input data applicable to the events is presented in Table 6.

1. RRC Pump Trip

As discussed above, a trip of one or both RRC pumps will cause an immediate reduction in power due to the decrease in core flow. A key factor affecting the rate at which the core flow will decrease is the inertia of the RRC pump. A large inertia will result in a slower coastdown of the pump and a correspondingly slower decrease in core flow, while a small inertia will result in a faster coastdown and a faster decrease in core flow. Because the RRC pumps have not been changed, the coastdown characteristics will be similar to the previous FSAR analyses of the RRC system events. Thus, the differences noted when comparing the Table 3 pump trip data for the ASD analysis with the Table 4 data for the original FSAR analysis are due to the differences in initial conditions (e.g., higher core thermal power) rather than the differences in the RRC pump drive system.

During normal operation, the ASD system uses two channels (12 pulse mode) to control the RRC pump drive motors. In the event one channel is lost, the operating mode is reduced to 6 pulse using the remaining channel. One channel is not capable of supporting the power requirements for pump drive motor operation at a speed of 63 Hz (1871 rpm). Therefore, the speed is automatically reduced to the capability of the remaining channel which is approximately 52 Hz. Because of the large torque capacity of a single channel in the ASD system, the loss of one channel has a moderate effect at high reactor power and a negligible effect at low reactor power. Thus, the loss of a single channel at high pump speed is a power decreasing transient and is mild in comparison to the one RRC pump trip event since the decrease of pump speed is limited. The loss of a single channel at low to moderate speed is a minor transient in which the remaining channel assumes the pump load.

2. RFC Failure - Decreasing Flow

Although possible malfunctions in the RFC system could introduce perturbations in core coolant flow, redundant and diverse rate limiters within the control system as well as the inherent inertia of the RRC pump and motor prevent the disturbance from being more severe than the pump trips already discussed. The most severe RFC system decreasing flow disturbance is a failure that causes a controller to move at its maximum rate to reduce pump speed. Such transients may be obtained by instantaneous failure of a controller output to its lower limits. The main difference between the postulated failure in one loop and two loops is the rate at which the controls allow the ASD to decrease pump speed. In the case involving two loops, a failure is assumed in the Manual Master Setpoint Station controller. The rate of speed change is determined by the speed demand limiters within the GE-FANUC and ASD MEM unit control logic (see Figure 3). Each limiter is designed to function independently to prevent the demand signal from causing an unacceptable rate of speed change. The GE-FANUC and ASD system have a high reliability with calculated failure probabilities of 1.25 E-06 and 4.26 E-06 per system demand, respectively. The failures of both of these limiters combined with an independent failure of the Master Setpoint Station controller is highly improbable. Thus, for the two loop controller failure event, the Individual Loop controllers are assumed to move at their maximum rate to decrease pump speed in both RRC loops. For the one loop controller failure event, a failure in the ASD MEM unit control logic is assumed causing the affected ASD to move at a higher than maximum rate to decrease pump speed in one loop. The plant system responses to a RFC failure - decreasing flow event for one and two loops are summarized in Table 3 and show that the disturbances are equal to or less than those of the corresponding RRC pump trip events.

3. RRC Pump Shaft Seizure

Seizure of a RRC pump shaft is considered an accident due to the low probability of such an occurrence. Therefore, the criteria placed on evaluating a pump shaft seizure is the same as that for other accidents such as a Loss of Coolant Accident (LOCA). However, the consequences of this event are very mild compared to accident acceptance criteria. While there will be a reduction in the CPR, it remains above the Minimum Critical Power Ratio (MCPR) criteria applied to moderate frequency events and no boiling transition should take place. The seizure of a pump shaft results in an instantaneous loss of pump speed and a rapid reduction of drive flow in the affected loop. This in turn results in a rapid decrease in core flow. Since this event is independent of the pump motor drive system, the differences noted when comparing the Table 3 (ASD analysis) pump seizure data with the Table 4 (original FSAR analysis) data are due to the differences in initial conditions (e.g., higher core thermal power) rather than the differences in the RRC pump drive systems.

4. RRC Pump Shaft Break

As with the RRC Pump Shaft Seizure event discussed above, the RRC Pump Shaft Break event is considered an accident due to the low probability of occurrence. Since the shaft seizure event is assumed to produce an instantaneous loss of pump speed, a shaft break cannot cause a more rapid loss of pump speed or decrease in core flow. Therefore, this event is bounded by the results of the shaft seizure event. Since the ASD will not affect the assumptions of the event analysis, this event continues to be bounded by the FSAR shaft seizure event.

**Reactivity and Power Distribution Anomalies**

As described in FSAR Chapter 15, anticipated operational occurrences included in this category are those that cause rapid increases in power due to increased core flow disturbance events. As might be expected, the opposite characteristics are seen for a flow increase event when compared with flow decrease events. A flow increase results in a power increase and a temporary drop in downcomer water level. For mild flow increases, the reactor will settle out at a new steady state with a higher power and core flow. If the flow change is large or rapid, the reactor will scram on a high neutron flux signal. The input data applicable to the events is taken at a decreased initial power level and flow than that presented in Table 6. However, the rod line remains the same.

The power increase caused by increased core flow results in a decrease in the CPR. However, the power and flow dependent MCPR has been chosen to provide ample margin for this type of event. In general, a lower initial core flow means that a large potential core flow increase is possible. For this reason, the flow dependent MCPR Operating Limit is higher for initial conditions at lower flows. The COLR for WNP-2 (Reference 3) includes a requirement that the operating MCPR must increase for core flow less than maximum (106% NBR). This requirement is based on the potential slow increase of core recirculation flow along the maximum flow control rod line to the upper limit on recirculation flow. The MCPR curve must account for the higher maximum core flow capability after ASD installation. The analyses for the change in core flow capability following ASD installation will be reflected in the COLR for WNP-2 as appropriate.

1. RFC Failure - Increasing Flow

An upscale failure in one or both loops of the RFC system can cause the core flow to increase. However, redundant and diverse maximum speed and rate limiters within the control system as well as the inherent inertia of the RRC pump and motor prevent the disturbance from becoming a limiting transient. Furthermore, events in this category generally result in a reactor scram due to high neutron flux. The most severe RFC system increasing flow disturbance is a failure that causes a controller to move at its maximum rate to increase pump speed. Such transients may be obtained by instantaneous failure of a controller output to its upper limits. The main difference between the postulated failure in one loop and two loops is the rate at which the controls allow the ASD to increase pump speed. In the case involving two loops, a failure is assumed in the Manual Master Setpoint Station controller. The rate of speed change is determined by the speed demand limiters within the GE-FANUC and ASD MEM unit control logic (see Figure 3). Each limiter is designed to function independently to prevent the demand

signal from causing an unacceptable rate of speed change. The GE-FANUC and ASD system have a high reliability with calculated failure probabilities of 1.25 E-06 and 4.26 E-06 per system demand, respectively. The failures of both of these limiters combined with an independent failure of the Master Setpoint Station controller is highly improbable. Thus, for the two loop controller failure event, the Individual Loop controllers are assumed to move at their maximum rate to increase pump speed in both RRC loops. For the one loop controller failure event, a failure in the ASD MEM unit control logic is assumed causing the affected ASD to move at a higher than maximum rate to increase pump speed in one loop. A summary of the responses to the RFC failure - increasing flow event for one and two loops is shown in Table 3. This event remains a non-limiting transient that does not challenge the RCPB or fuel integrity.

2. Abnormal Startup of Idle RRC Loop

The startup of an idle RRC pump will result in increased core flow and power. If started under normal conditions, the idle loop temperature will be no lower than 50°F below the operating loop temperature and the effect of this transient on surface heat flux and the CPR is mild. However, the impact on fuel performance would be greater if the idle loop were filled with cold water. Since the RRC piping in each loop contains a large volume of water, improper startup of a loop filled with cold water would cause a power increase due to increased flow and increased subcooling. For the transient analysis, it was assumed that initial pump speed and drive flow in the operating loop are approximately 25% of rated and idle loop temperature is 100°F. Upon startup of the idle loop, it was assumed that the pump speed and drive flow are increased to 100% of rated at the maximum speed controller demand rate. A summary of the responses to the abnormal startup of an idle loop event is shown in Table 3. As was concluded for the RFC failure - increasing flow event, this event remains a non-limiting transient that does not challenge the RCPB or fuel integrity.

## ACCIDENT ANALYSIS

The limiting accident involving the RRC system is a design basis LOCA due to a large recirculation line break. Implementation of the ASD design results in the following post LOCA considerations:

1. No credit in a LOCA analysis is allowed for nonsafety-related power sources. Thus, the RRC pump motors are assumed to trip at time zero in the LOCA analysis due to a loss of offsite power. The availability of offsite power will not adversely affect the results of the LOCA analysis as it applies to the ASDs. Therefore, changing from a flow control valve design to an ASD design will have a negligible effect.

2. Compared to the existing two-speed RRC pump motor drive system, the ASD variable speed system will allow the pumps to operate at a lower initial speed (between 25% and 100%) over the majority of the power to flow map. This could result in slightly faster pump coastdown times at rated as well as off-rated conditions.

The effect of these changes on the overall Emergency Core Cooling System (ECCS) performance analysis results is considered negligible. The slightly faster RRC pump coastdown time described above could lead to a slightly earlier loss of nucleate boiling at a higher power node in the core. However, with the film boiling heat transfer following loss of nucleate boiling correlations applied in the Reference 4 analysis, the impact on the calculated fuel peak cladding temperature (PCT) would not be significant. Thus, implementation of the ASD design change in the RRC system will not be restricted by ECCS considerations.

The accident radiological dose calculations were performed to meet the requirements of Regulatory Guide 1.3, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss-of-Coolant Accident for Boiling Water Reactors." This guide requires an assumption that a certain percentage of the radioactive material available in the fuel is immediately available for leakage from the containment. To release such a fraction would require the fuel PCT to exceed the 10 CFR 50.46 limit of 2200°F for a significant period of time. The LOCA analysis for WNP-2 demonstrated that the PCT would be limited to 1440°F. Thus, the NRC assumption for the radiological calculations is non-mechanistic and very conservative. Since the ASDs do not change the inventory of material available for release per this assumption, they will not affect the dose calculations.

## CONTAINMENT ANALYSIS

An analysis was performed to determine the impact of the ASD design change on the short-term containment response to a design basis LOCA. The only containment response parameters affected by the change from a flow control valve design to an ASD design are the break flow and enthalpy. The break flow and enthalpy for the ASD system were calculated and compared to results obtained from the same type of calculation for the existing flow control valve design. This comparison showed that the change to the ASD design has no significant impact on the break flow and enthalpy during a design basis LOCA. Therefore, it has no significant impact on the existing containment response.

## ATWS ANALYSIS

The only impact on an ATWS event in changing from the existing flow control valve design to the ASD design results from the change in rate of recirculation flow coastdown following a RPT. Since the RRC pump and motor inertia have not changed, the change in coastdown would be due to differences in the RPT delay time, initial pump speed, and the recirculation line flow losses. The impact of the change in rate of recirculation flow coastdown on long term ATWS performance to control suppression pool heatup is expected to be insignificant since the change in the amount of steam directed to the suppression pool through the safety relief valves during an ATWS event would not change significantly. An assessment of the changes in initial pump speed and the recirculation line flow losses on a short term ATWS showed the peak vessel pressure to be 33 psi below the 1500 psig acceptance criteria. The approximate 10 millisecond additional RPT delay time at 88% core flow with the ASD design (see Table 5) is estimated to increase peak vessel pressure by less than 2 psi during an ATWS event. Therefore, changing from the flow control valve design to the ASD design will have limited impact on an ATWS event and adequate margin to the ATWS acceptance criteria will be maintained.

## REACTOR CORE STABILITY ANALYSIS

The core stability margin is known to be low for RRC system alignments and power and flow conditions associated with minimum flow control valve position and low pump speed. This is especially true at higher power levels where the RRC pump motors are shifted from low speed to high speed while maintaining power and flow above the flow control valve cavitation interlock. FSAR Section 4.4 describes the current power to flow limitations. Since the ASD design change will permanently block open the flow control valves, flow control valve cavitation will no longer be an operational concern, thus allowing greater maneuverability in the low core flow region of the power to flow map. In addition, the ASD system does not require a shift from low speed to high speed which provides greater margin to the region of known lower stability. The ASD system will also allow the RRC pump speed to be increased along a lower flow control line that is farther from the stability exclusion region since the cavitation interlock is cleared at a lower power level. Therefore, due to the greater reactor power and flow maneuverability and the increased margin to regions of known low stability, power oscillations are less likely to occur during normal plant operation with the ASD system than with the existing flow control valve system.

## TECHNICAL SPECIFICATIONS

As described in detail above, the Supply System is planning to upgrade the RRC system flow control design from an analog-hydraulic flow control valve system to dual channel ASDs and a digital RFC system. This design change will allow variable speed operation of the RRC pumps for improved flow control and increased RFC system reliability. Based on a review of the WNP-2 Technical Specifications, changes to the existing specifications are necessary to reflect the change in RRC system flow control design and mode of operation. The proposed changes are described below. Appendix E includes the actual affected pages from the Technical Specifications with the proposed changes indicated by markups.

### Limiting Conditions for Operation (LCOs) 3.2.7.a and 3.2.7.b

Delete the phrases ". . . with recirculation flow control valve manipulation" and "or shifting." These changes are required to allow the change in flow control mode. A description of the method used for "increasing core flow" is not necessary because RRC pump speed control will be the only method for flow control. Also, following ASD implementation, the pumps will no longer be "shifted" to increase flow, so the term is being deleted. Since the resulting control functions are comparable, the change has no safety significance.

**LCO 3.2.8.a**

Delete the phrases ". . . with recirculation flow control valve manipulation" and "or shifting." These changes are required to allow the change in flow control mode. A description of the method used for "increasing core flow" is not necessary because RRC pump speed control will be the only method for flow control. Also, following ASD implementation, the pumps will no longer be "shifted" to increase flow, so the term is being deleted. Since the resulting control functions are comparable, the change has no safety significance.

**LCO 3.4.1.1.a.2**

Delete the phrases ". . . with flow control valve manipulation" and "or shifting." These changes are required to allow the change in flow control mode. A description of the method used for "increasing core flow" is not necessary because RRC pump speed control will be the only method for flow control. Also, following ASD implementation, the pumps will no longer be "shifted" to increase flow, so the term is being deleted. Since the resulting control functions are comparable, the change has no safety significance.

**LCO 3.4.1.1.a.3.a and Surveillance Requirement (SR) 4.4.1.1.1.a**

Delete the LCO and SR. The ASD design change replaces the "Local Manual" control feature with an "Individual Loop Control" feature for manual RRC system flow control. The new RFC system design will automatically place the controls in the "manual" individual loop mode with one loop not operating. Thus, the 4 hour LCO to place the controls in "Local Manual" with one RRC system loop not operating is no longer required since the comparable function will be performed automatically. Similarly, the 8 hour surveillance requirement (SR) to verify the controls in "Local Manual" is no longer required since the RFC system will automatically maintain the controls in the individual loop mode with one loop not operating. This automatic design feature eliminates an operator action following a postulated RRC pump trip transient, thus reducing the potential for error. Furthermore, even if the automatic transfer to individual mode failed, there would not be any adverse affects on either the operating loop or the non-operating loop. The operating loop controls would control the loop flow normally based on the set demand since there are no automatic feedback controls. The non-operating loop controls would have no effect because the associated ASD channels would be shutdown and the pump would be tripped.

**SR 4.4.1.1.3**

Modify the SR to read as follows:

*"4.4.1.1.3 Each reactor coolant system recirculation loop pump speed controller shall be demonstrated OPERABLE at least once per 24 months by verifying that the average rate of change of pump speed is:*

*a. Less than or equal to 10% of rated pump speed per second increasing, and*

*b. Less than or equal to 10% of rated pump speed per second decreasing."*

Currently, SR 4.4.1.1.3.a provides assurance that in the event of a loss of hydraulic pressure the flow control valves would fail in an "as is" position. SR 4.4.1.1.3.b currently ensures that the flow control valves are limited in their rate of opening and closing. These SRs together provide assurance that the RRC system flow and rate of change of flow remain within the limits of the transient analyses. The limiting transients impacted by these SRs are the fast opening and fast closing of both flow control valves. The analogous events for the ASD design are the RFC failure - increasing flow and decreasing flow transients. The rate of change of flow, either increasing or decreasing, is limited by redundant and diverse rate of speed change limiters within the GE-FANUC and ASD MEM unit control logic for the ASDs as well as the inherent RRC pump and motor inertia. Maximum flow is limited by redundant and diverse maximum speed limiters which are also contained in the GE-FANUC and ASD MEM unit control logic as well as an overfrequency protection relay for each ASD. The overfrequency protection relay monitors the output of the ASD and will trip the RRC pump in the affected loop if the frequency increases to the relay setpoint. The maximum speed and rate of speed change limiters, the overfrequency protection relays, and the RRC pump and motor inertia function collectively to provide assurance that maximum core flow and rate of change of flow will remain within analyzed limits and the plant will be protected from flow runout events.

SR 4.4.1.1.3.a will no longer be applicable following implementation of the ASDs as the flow control valves are being deactivated and the associated hydraulic system components are being removed from the plant as part of the ASD design change. Furthermore, a comparable SR to verify that the ASDs fail "as is" is not necessary because the most limiting failures result in increasing or decreasing flow transients that are bounded by the RFC failure - increasing flow and decreasing flow transient analyses.

The ASD overfrequency protection relays, in conjunction with the GE-FANUC and ASD MEM unit maximum speed limiters, support the requirement to limit the maximum core flow in order to provide protection against flow runout events. This design feature is analogous to the electrical and mechanical stops on the scoop tube positioner for motor-fluid-coupler generator sets used in BWR 3 and 4 plants. The electrical and mechanical stops on the motor-generator sets prevent the RRC pumps from exceeding pre-determined overspeed limits and are assumed to function in analyzed plant transients to ensure that MCPR limits are not exceeded. For WNP-2, the ASD overfrequency protection relays ensure that MCPR limits are not exceeded by tripping the ASDs on an uncontrolled frequency increase in the highly unlikely event that both the GE-FANUC and the ASD MEM unit maximum speed limiters fail. The MCPR limits are maintained in WNP-2 Technical Specification 3.2.3 and the COLR. Since the overfrequency relay settings can vary on a fuel cycle specific basis, it is proposed that the settings not be maintained in Technical Specifications but, instead, be maintained in plant procedures. The

overfrequency relay settings can be adequately defined and controlled in plant procedures which require change control in accordance with 10 CFR 50.59. This approach provides an effective level of regulatory control and provides for a more appropriate change control process. NRC and Supply System resources associated with processing Technical Specification amendments will be reduced while having no impact on safety. This is consistent with the approach taken in the BWR/4 Improved Technical Specifications (NUREG-1433) for the electrical and mechanical stops on the motor-generator sets.

For the ASD design, rate of change limiters within the GE-FANUC and ASD MEM unit control logic and the inherent inertia of the RRC pump and motor maintain the rate of change of flow within the limits of the RFC failure - increasing flow and decreasing flow transient analyses. The most severe RFC failure - increasing flow and decreasing flow transients occur when both Individual Loop controllers fail to their upper or lower limits causing the RRC pumps in both loops to increase or decrease core flow. To provide assurance that the GE-FANUC and ASD MEM unit rate limiters for the Individual Loop controllers will maintain the rate of speed change assumed in the analyses, SR 4.4.1.1.3.b is being replaced with SR 4.4.1.1.3 to periodically verify that the controllers maintain the rate of change of RRC pump speed at less than or equal to 10% of rated pump speed per second increasing and decreasing.

The 24 month frequency for the new SR 4.4.1.1.3 was established based on the need to perform the SR under the conditions that apply during a plant outage and the potential for an unplanned transient if the SR was performed with the reactor at power. The GE-FANUC and ASD system have high reliabilities for a nonsafety-related system with calculated failure probabilities of 1.25 E-06 and 4.26 E-06 per system demand, respectively. Since the independent and concurrent failure of both the GE-FANUC and ASD MEM unit limiters is highly improbable, it is concluded that a 24 month frequency for the SR is acceptable from a reliability standpoint.

SR 4.4.1.2.1.a

Replace the phrase ". . . flow control valve position-loop flow . . ." with *". . . recirculation pump speed and flow . . ."* This change is required because the "flow control valve position-flow" feature of the existing flow control system is being replaced with the "RRC pump motor speed demand reference signal-loop flow" feature of the ASD system. Since the relative characteristics are comparable, the change has no safety significance.

SR 4.4.1.2.2.a

Replace the phrase ". . . recirculation flow control valve position-loop flow . . ." with *". . . recirculation pump speed and flow . . ."* This change is required because the "flow control valve position-flow" feature of the existing flow control system is being replaced with the "RRC pump motor speed demand reference signal-loop flow" feature of the ASD system. Since the relative characteristics are comparable, the change has no safety significance.

**BASES 3/4.3.4**

The Supply System will add the following sentence to the Bases upon approval of the proposed changes to the Technical Specifications: *"The response times assume a 60 Hz output frequency from the adjustable speed drives (ASDs)."*

**Table 3.6.3-1.a**

Delete Containment Isolation Valve Function "Reactor Recirculation Hydraulic Control (e)(l)," including the following 16 valve numbers listed under the function:

| | |
|---|---|
| "HY-V-17A,B | HY-V-33A,B |
| HY-V-18A,B | HY-V-34A,B |
| HY-V-19A,B | HY-V-35A,B |
| HY-V-20A,B | HY-V-36A,B." |

Delete the valve isolation group number ("4") and isolation time ("15") listed for the Function. Also delete Footnote "l" at the end of the Table, which reads: "The isolation logic associated with the reactor recirculation hydraulic control containment isolation valves need not meet single failure criteria for OPERABILITY for a period ending no later than May 15, 1995."

As previously discussed, the RRC system flow control valves are being deactivated and the associated hydraulic system components are being removed from the plant as part of the ASD design change. Removal of the hydraulic system components allows 8 hydraulic fluid line containment penetrations to be capped. This in turn allows removal of the 16 associated containment isolation valves indicated above. Removal of these potential containment penetration leakage paths will improve plant safety. Since the valves will be removed from the plant, this proposed change deletes the references to the valves and their function. Footnote "l" is also being deleted since the effective date has expired and because the associated hydraulic control containment isolation valves are being removed. These proposed changes simply update the Technical Specifications to the new plant configuration.

# APPENDIX C

## FIGURES AND TABLES

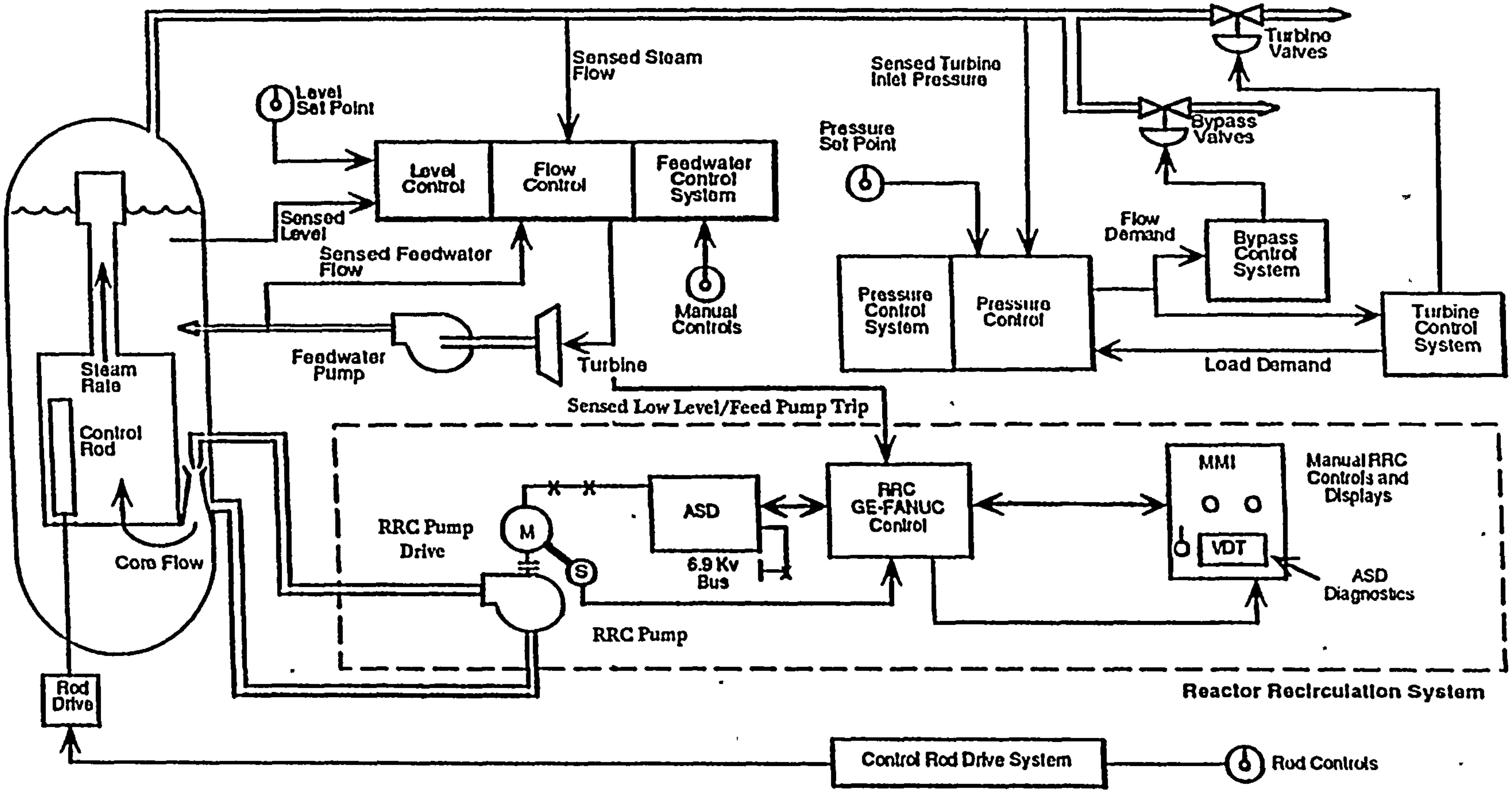
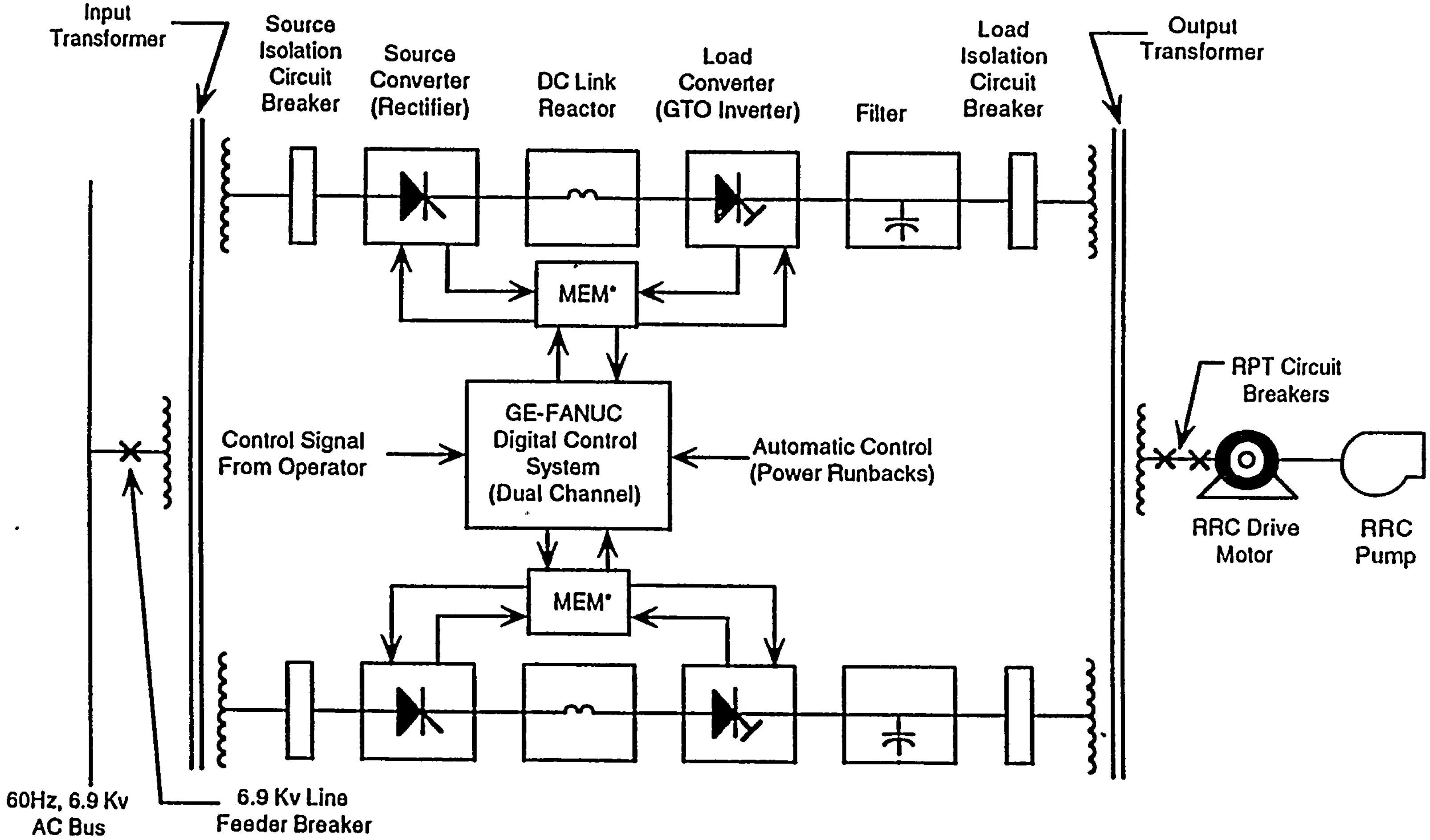
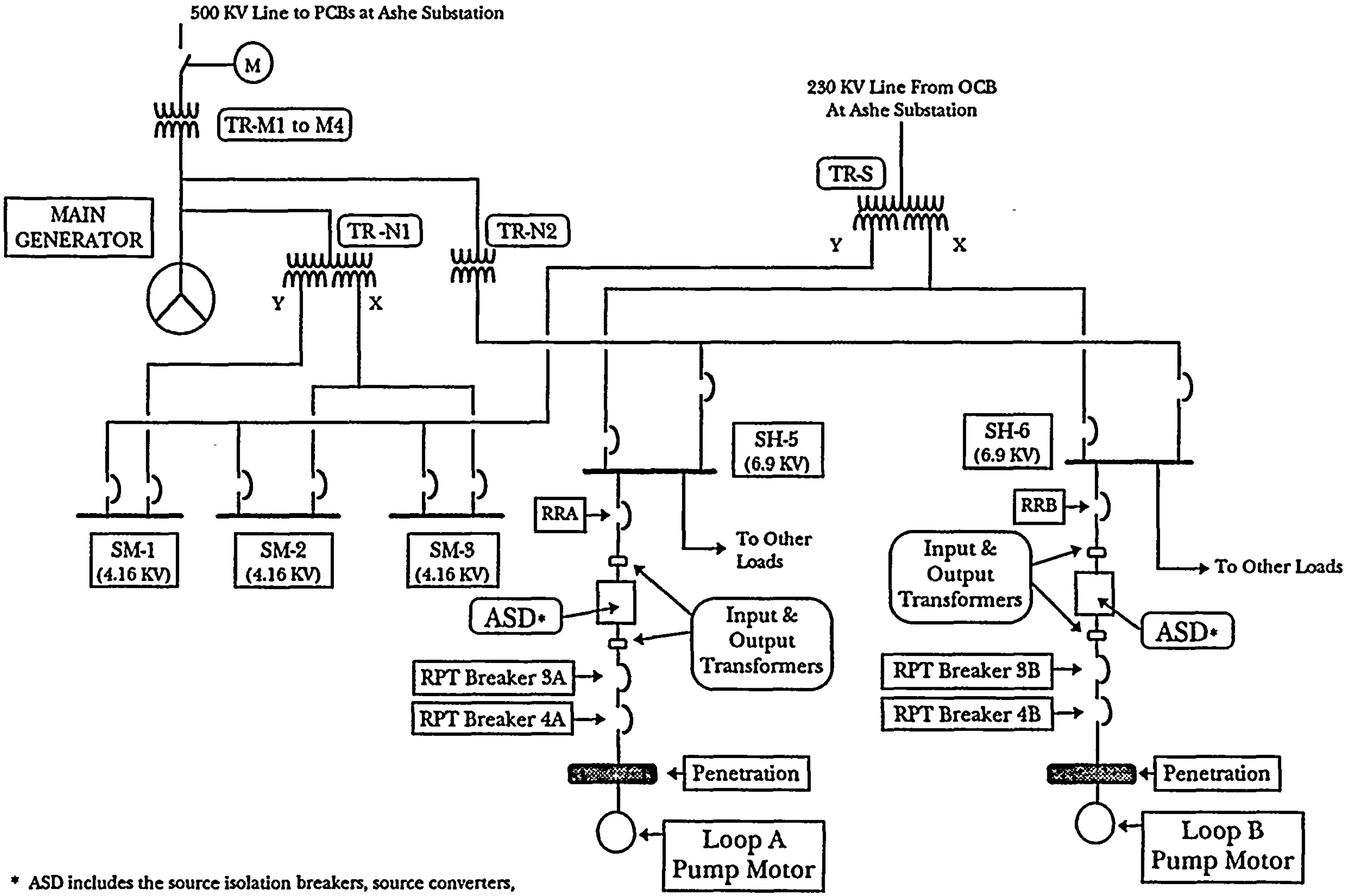



**Figure 1 - Adjustable Speed Drive Control Design**




* Medium Electronics Module Unit (microprocessor controlling the drive)

**Figure 2A - Simplified Diagram of ASD System (Typical RRC System Loop Showing Dual Channel ASD)**




* ASD includes the source isolation breakers, source converters, DC link reactors, load converters, filter capacitors, load isolation breakers and controls for two channels as shown on Figure 2A.

**Figure 2B - Simplified Diagram of WNP-2 Grid with ASDs**

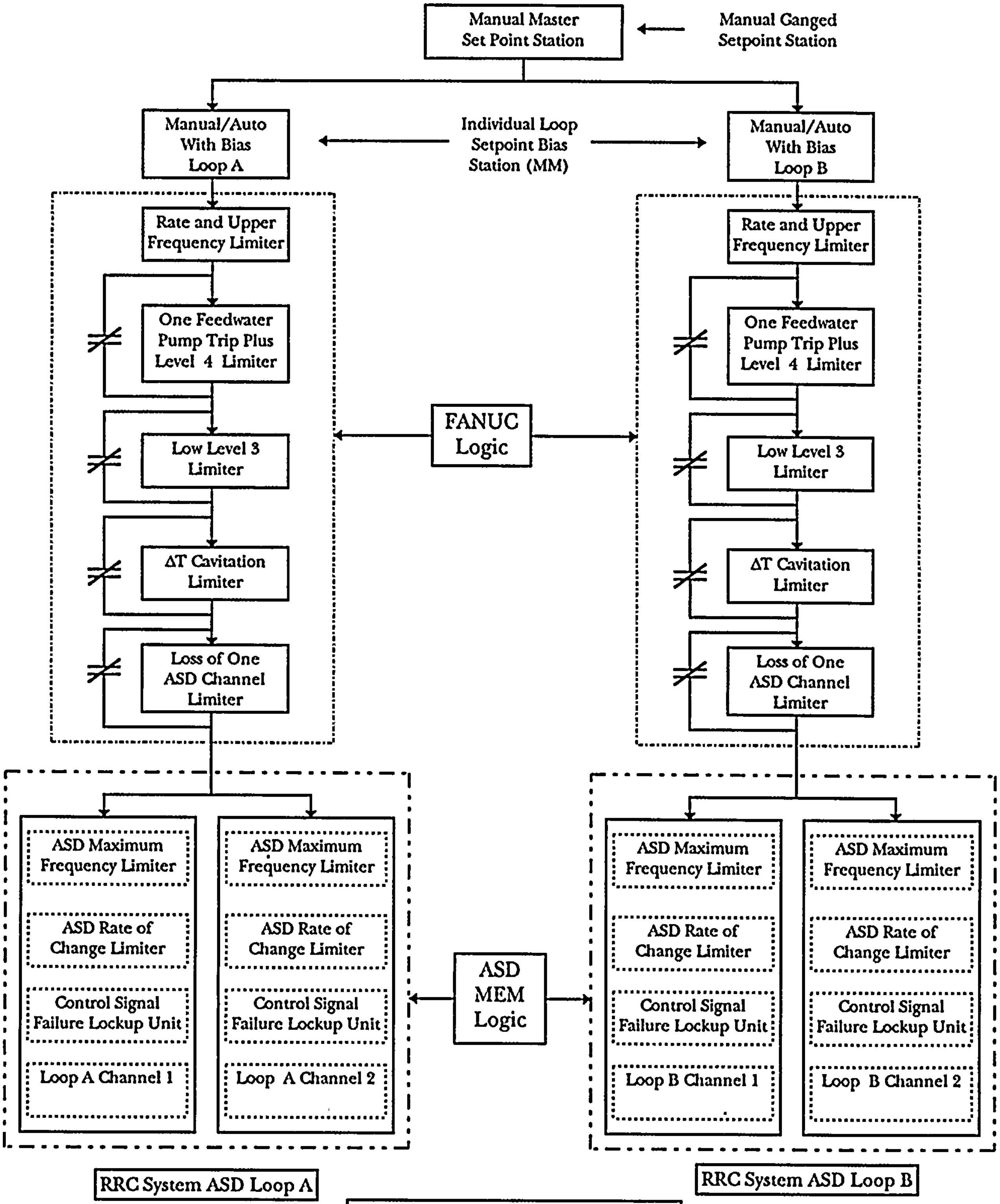



Figure 3 - WNP-2
RFC System Simplified
Control Logic Block Diagram

## Table 1

### Operating Conditions for 100%, 105%, & 110% Pump Speeds*

| | 100% Speed | 105% Speed | 110% Speed |
|---|---|---|---|
| Pump Speed, rpm | 1,782 | 1,871 | 1,960 |
| Flow Rate, gpm | 43,256 | 45,410 | 47,566 |
| Pump Head, ft | 866 | 955 | 1,048 |
| Pump Horsepower, HP | 8,221 | 9,502 | 10,912 |
| Torque, ft-lb | 24,229 | 26,673 | 29,240 |

* The 100% case represents the current rated pump speed. The 105% case represents the new operating limit. The 110% case does not represent an operating condition, and serves only to guide the selection of design margins.

Table 2

## ASD ALARMS & SHUTDOWNS (1)

| ALARMS | SHUTDOWNS |
|---|---|
| Coolant Level Low | Coolant Level Low |
| Coolant Pressure Low or Pump Loss | Coolant Pressure Low or Pump Loss |
| Coolant Temperature High or Heat Exchanger Blower Loss | Coolant Temperature High or Heat Exchanger Blower Loss |
| Coolant Resistance Low | Coolant Resistance Low |
| Link Reactor Overtemperature | Link Overvoltage |
| GTO Gate Driver Alarm | GTO Gate Driver Fault |
| P70 Gating Supply Voltage Dip (2) | P70 Gating Supply Undervoltage (2) |
| Chopper Power Supply Voltage Dip | Chopper Undervoltage |
| I/O Addressing Problem | Master/Slave Unbalance |
| Microprocessor Interrupt | Source Low Line Fault |
| Loss of Speed Control | Source Overcurrent |
| Loss of Speed Reference | Load Overcurrent |
| GTO Freeze | Source Phase Lock Loop Fault |
| Bridge Filter Fuse | Load Phase Lock Loop Fault |
| Source Line Dip | Stack Overflow |
| Loss of Run Permissive | Source Differential Current Fault |
| Bad EPROM Initialization | Source Backup Overcurrent |
| Torque Command Unbalance | Load Backup Overcurrent |
| Excitation Command Unbalance | Source Overvoltage |
| | Load Overvoltage |
| | Overspeed Fault |
| | Ground Fault |
| | XDCD Config. Error Fault (3) |
| | Source Reverse Phase Sequence Fault |
| | Breaker Pre-Trip Signal from either a RPT Breaker (3A/B, 4A/B), Source Breaker (RRA/RRB), Source Isolation Breaker or Load Isolation Breaker. (4) |
| | Operator Manual Shutdown Signal |

(1) The ASD MEM unit shuts the ASD down by ceasing firing signals to the SCRs.
(2) SCR firing circuit 70 Volt gating power supply voltage dip or undervoltage.
(3) Error between the number of GTOs in the software setting versus the number detected by analog signals.
(4) Refer to Figures 2A and 2B in this report for the location of these breakers.

## Table 3

## Summary of Results for ASD Recirculation System Events

| Description | Maximum Neutron Flux (% NBR)* | Maximum Dome Pressure (psig) | Maximum Vessel Pressure (psig) | Maximum Steam Line Pressure (psig) | Maximum Core Average Surface Heat Flux (% of Initial) |
|---|---|---|---|---|---|
| Recirculation Pump Trip – One Pump (1) | 106.2 | 1020 | 1059 | 1012 | 100.0 |
| Recirculation Pump Trip – Two Pump (1) | 106.2 | 1077 | 1088 | 1076 | 100.0 |
| Recirc Flow Control Failure: Decreasing Flow – One Pump (1) | 106.2 | 1020 | 1059 | 1012 | 100.0 |
| Recirc Flow Control Failure: Decreasing Flow – Two Pump (1) | 106.2 | 1061 | 1072 | 1061 | 100.0 |
| Recirculation Pump Seizure (1) | 106.2 | 1099 | 1108 | 1098 | 100.0 |
| Recirculation Flow Control Failure: Increasing Flow – One Pump (2) | 136.2 | 990 | 1009 | 986 | 126.9 |
| Recirculation Flow Control Failure: Increasing Flow – Two Pump (2) | 153.4 | 1006 | 1033 | 1001 | 149.4 |
| Abnormal Startup of Idle Recirculation Loop (3) | 124 | 1004 | 1026 | 998 | 190.2 |

* NBR = 3486 MW(t)

Initial Conditions :

| | Thermal Power (MW) | Core Flow (M#/hr) |
|---|---|---|
| (1) | 3702 | 108.5 |
| (2) | 2126 | 41.2 |
| (3) | 2022 | 36.9 |

## Table 4

## Summary of FSAR Analyzed Recirculation System Events

| FSAR Figure | Description | Maximum Neutron Flux (% NBR)* | Maximum Dome Pressure (psig) | Maximum Vessel Pressure (psig) | Maximum Steam Line Pressure (psig) | Maximum Core Average Surface Heat Flux (% of Initial) |
|---|---|---|---|---|---|---|
| 15.3-1 | Trip of One Recirculation Pump Motor | 104.4 | 1021 | 1061 | 994 | 100.0 |
| 15.3-2 | Trip of Both Recirculation Pump Motors | 104.4 | 1104 | 1116 | 1100 | 100.1 |
| 15.3-3 | Fast Closure of One Main Recirc Valve | 104.3 | 1101 | 1115 | 1097 | 100.0 |
| 15.3-4 | Fast Closure of Two Main Recirc Valves | 104.4 | 1105 | 1115 | 1100 | 100.0 |
| 15.3-5 | Seizure of One Recirculation Pump | 104.3 | 1105 | 1117 | 1100 | 100.2 |
| 15.4-7 | Fast Opening of One Main Recirc Valve | 282.9 | 980 | 1000 | 971 | 141.0 |
| 15.4-8 | Fast Opening of Both Main Recirc Valves | 222.2 | 977 | 1000 | 969 | 134.6 |
| 15.4-6 | Abnormal Startup of Idle Recirculation Loop | 94.2 | 981 | 995 | 970 | 146.6 |

* NBR = 3323 Mw(t)

## Table 5

### Summary of Results for ASD Recirculation System Events: Increase in Reactor Pressure

| Description | | Maximum Neutron Flux (% NBR)* | Maximum Core Average Surface Heat Flux (% of Initial) | ΔCPR 8x8 / 9x9 |
|---|---|---|---|---|
| Generator Load Rejection with Bypass Failure | | | | |
| 104.1%P, 106%F; | RPT= 190 msec [1] | 348 | 119 | 0.116 / 0.149 |
| 104.1%P, 106%F; | RPT= 190 msec [2] | 350 | 118.5 | 0.118 / 0.153 |
| 104.1%P, 106%F; | RPT= ~186 msec [3] | 349 | 118.5 | 0.118 / 0.151 |
| 104.1%P, 94%F; | RPT= 190 msec [2] | 311 | 118.2 | 0.111 / 0.145 |
| 104.1%P, 94%F; | RPT= ~195 msec [3] | 311 | 118.2 | 0.111 / 0.145 |
| 100%P, 88%F; | RPT= 190 msec [2] | 289 | 114. | 0.111 / 0.145 |
| 100%P, 88%F; | RPT= ~200 msec [3] | 291 | 114.3 | 0.113 / 0.147 |

* NBR = 3486 MW(t)

[1] Previous analysis results with transitionary version of the one-dimension reactor model (ODYN).
[2] Current analysis results with the final version of the one-dimensional model without ASDs.
[3] Current analysis results with ASDs.

Initial Conditions: %P = % Thermal Power (100% = 3486MW)
%F = % Core Flow (100%: 108.5 M#/Hr)

## Table 6

### Input Parameters and Initial Conditions for ASD Transients *

| | | |
|---|---|---|
| 1. | Thermal Power Level, MWt | |
| | Rated Value | 3486 |
| | Analysis Value | 3702 |
| 2. | Steam Flow, lbm per hour | |
| | Analysis Value | $1.609 \times 10^7$ |
| 3. | Core Flow, lbm per hour | $1.085 \times 10^8$ |
| 4. | Feedwater Flow Rate, lbm per sec | 4471 |
| 5. | Feedwater Temperature, °F | 426 |
| 6. | Vessel Dome Pressure, psig | 1020 |
| 7. | Turbine Bypass Capacity, % NBR | 22.7 |
| 8. | Core Coolant Inlet Enthalpy, Btu per lbm | 528.3 |
| 9. | Turbine Inlet Pressure, psig | 992 |
| 10. | Core Average Fuel Cladding Gap Conductance, Btu per second-ft$^2$-°F | 0.3608 |
| 11. | Doppler Coefficient, – ¢ per °F | |
| | Nominal | 0.311 |
| | Analysis Increasing Power | 0.295 |
| | Analysis Decreasing Power | 0.327 |
| 12. | Void Coefficient, – ¢ per % Rated Voids | |
| | Nominal | 12.74 |
| | Analysis Increasing Power | 15.93 |
| | Analysis Decreasing Power | 12.10 |
| 13. | Core Average Rated Void Fraction, % | 41.24 |
| 14. | High Neutron Flux, % NBR Analysis Setpoint | 130 |

**Table 6**

**Input Parameters and Initial Conditions for ASD Transients * (Continued)**

| | | |
|---|---|---|
| 15. | Vessel Level Trips, ft above Dryer Skirt Bottom | |
| | Level 8 (L8), inches | 59.5 |
| | Level 3 (L3), inches | 7.5 |
| 16. | Recirculation Pump Trip Delay, seconds | 0.19 |
| 17. | Recirculation Pump Trip Inertia Time Constant, seconds | 6 |
| 18. | Two loop flow increase/decrease rate of flow change, %/sec. | 10 |
| 19. | Single loop flow increase/decrease rate of flow change, %/sec. | 25 |

* These values are the nominal values used in the transient analysis which can vary depending on the particular transient being analyzed. Significant changes from these values are indicated in the discussion of the particular transient.

## APPENDIX D

## EVALUATION OF NO SIGNIFICANT HAZARDS CONSIDERATION

In accordance with the criteria for defining a significant hazards consideration established in 10 CFR 50.92, the Supply System has evaluated the proposed amendment to the WNP-2 Technical Specifications that will allow implementation of the design change to replace the existing Reactor Recirculation (RRC) flow control system with an adjustable speed drive (ASD) system. Based on the evaluation, the Supply System has determined that the proposed changes do not represent a significant hazards consideration. The following discussion is provided in support of this conclusion.

1. ***Does the change involve a significant increase in the probability or consequences of an accident previously evaluated?***

   The ASDs and a new digital recirculation flow control (RFC) system will replace the existing flow control valves and analog-hydraulic RFC system as the means of varying the recirculation flow rate. The flow control valves will be deactivated and permanently blocked open and the associated hydraulic system components will be removed from the plant. Removal of the hydraulic components will allow 8 hydraulic fluid line containment penetrations to be capped. This in turn will allow removal of the 16 associated containment isolation valves. The RRC system has no active safety-related function and the ASDs and RFC system are classified as nonsafety-related. While the existing flow control valve design varies the flow rate by throttling the flow, the ASDs will provide variable frequency power to each RRC pump motor to vary the pump speed and thereby the system flow. The ASDs are a solid-state variable frequency power supply design that are capable of delivering the power required by each pump motor for normal operation over an output frequency range of approximately 15 Hz to 63 Hz to enable the pump to operate over the range of 25% to 105% of rated pump speed. Failure probabilities of 1.25 E-06 and 4.26 E-06 per system demand were calculated for the digital RFC system GE-FANUC control logic and the entire ASD system, respectively. These failure probabilities are considered low for nonsafety-related systems and translate to high system reliability.

   The limiting accident involving the RRC system is a Loss of Coolant Accident (LOCA) due to a large break in a recirculation line. Since no credit is allowed in a LOCA analysis for nonsafety-related power sources, the RRC pump motors are assumed to trip at time zero due to a loss of offsite power. The availability of offsite power will not adversely affect the results of the LOCA analysis as it applies to the ASDs. Thus, changing from a flow control valve design to an ASD design will have a negligible effect on the analytical results of the LOCA analysis. The change to an ASD design will also have a negligible effect on the Emergency Core Cooling System (ECCS) performance analysis since the results are bounded by the existing single-loop operation (SLO) analysis which assumes no credit for performance of the RRC system. Since the SLO ECCS analysis results have substantial margin to the 2200°F peak cladding temperature (PCT) acceptance criterion of 10 CFR 50.46, implementation of the ASD design will not be restricted by ECCS considerations.

Accident radiological dose calculations were performed in accordance with Regulatory Guide 1.3, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss-of-Coolant Accident for Boiling Water Reactors." The guide assumes that a certain percentage of the radioactive material available in the fuel is immediately available for leakage from the containment. This release fraction requires the PCT of the fuel to exceed 2200°F for a significant period of time. As indicated above, the bounding SLO ECCS analysis has a substantial margin to the 2200°F acceptance criterion. The NRC assumption for the radiological calculations is, therefore, non-mechanistic and very conservative. Since the ASDs do not change the inventory of material available for release per this assumption, they will not affect the dose calculations.

The potential impact of the ASDs on containment and RRC system pressure containing components was evaluated. It was determined that the ASDs will have no significant impact on the existing containment analysis and will produce acceptable loads on the RRC system pressure containing components. Therefore, based on the analysis, neither the integrity of the reactor coolant pressure boundary (RCPB) nor the probability of a LOCA will be affected by implementation of the ASD design.

The Bonneville Power Administration (BPA) transmission system (grid) power supply was analyzed to determine if the ASD rectifier harmonics would significantly impact the power supply for safety-related equipment buses. Since the buses that supply the ASDs are separated from safety-related buses during normal plant operation, the ASDs will not significantly increase the harmonic distortion present on the safety-related equipment buses prior to a LOCA. During a LOCA, the pumps would be tripped or runback to 25% speed, depending on the severity of the event, which would reduce the harmonics on the ASD supply buses. If the safety-related equipment buses are supplied by a diesel generator during a LOCA, the ASDs cannot influence the safety-related buses because the power supplies are isolated. Thus, the ASDs will not adversely affect any safety-related equipment power supplies or the capability of the plant to mitigate the consequences of an accident.

There are twelve proposed changes to the Technical Specifications that update the requirements and reflect the change from a flow control valve design to an ASD design. Six of the proposed changes result in requirements that are comparable to existing requirements and as such have no impact on the probability or consequences of a previously analyzed accident. However, four of the proposed changes delete existing requirements that are no longer applicable or necessary after the ASD design change is implemented, one change deletes a footnote because the effective date has expired, and one change modifies an existing requirement based on revised transient analyses assumptions attributed to the ASD design change. The six changes that delete or modify existing requirements are further discussed below.

The ASD design change replaces the "Local Manual" control feature with an "Individual Loop Control" feature for manual RRC system flow control. The new RFC system design will automatically place the controls in the "manual" individual loop mode with one loop not operating. Thus the 4 hour Limiting Condition for Operation (LCO) to place the controls in "Local Manual" with one RRC system loop not operating is no longer required since the comparable function will be performed automatically. Similarly, the 8 hour surveillance requirement (SR) to verify the controls in "Local Manual" is no longer required since the RFC system will automatically maintain the controls in the individual loop mode with one loop not operating. This automatic design feature eliminates an operator action following a postulated RRC pump trip transient, thus reducing the potential for error. Furthermore, even if the automatic transfer to individual mode failed, there would not be any adverse affects on either the operating loop or the non-operating loop. The operating loop controls would control the loop flow normally based on the set demand since there are no automatic feedback controls. The non-operating loop controls would have no effect because the associated ASD channels would be shutdown and the pump would be tripped.

The ASD design change will cap the 8 hydraulic fluid line containment penetrations for the flow control valves, allowing removal of the 16 associated hydraulic control containment isolation valves. Removal of these potential containment penetration leakage paths will likely reduce the consequences of an accident. Since the valves will be removed from the plant, the proposed changes to the Technical Specifications include a change that deletes the references to the valves and their function. The associated footnote is also being deleted because the effective date has expired and because it pertains to the hydraulic system containment isolation valves which are being removed. These proposed deletions simply update the Technical Specifications to the new plant configuration.

The proposed changes to the Technical Specifications also delete the SR verifying that the flow control valves fail "as is" on a loss of hydraulic pressure and modifies the SR verifying that the rate of flow control valve opening and closing is within the analytical limits. The SR being deleted will no longer be applicable following implementation of the ASDs as the flow control valves are being deleted and the associated hydraulic system components are being removed from the plant as part of the ASD design change. Furthermore, a comparable SR to verify that the ASDs fail "as is" is not necessary because the most limiting failures result in increasing or decreasing flow transients that are bounded by the RFC failure - increasing flow and decreasing flow transient analyses. Therefore, the deletion of the SR will not increase the probability or consequences of a previously analyzed accident. The SR being modified will also not be applicable following implementation of the ASDs since it pertains to the flow control valves which are being deactivated. For the ASD design, redundant and diverse rate of change limiters within the GE-FANUC and ASD control logic and the inherent inertia of the RRC pump and motor maintain the rate of change of flow within the limits of the RFC failure - increasing flow and decreasing flow transient analyses. The most severe RFC failure - increasing flow and decreasing flow transients occur when both individual loop controllers fail to their upper or lower limits causing the RRC pumps in both loops to

increase or decrease core flow. To provide assurance that the GE-FANUC and ASD limiters for the individual loop controllers will maintain the rate of speed change assumed in the analyses, the SR verifying the flow control valve opening and closing rate is being modified to periodically verify that the controllers maintain the rate of change of RRC pump speed within the analytical limits. A 24 month frequency was established for the modified SR based on the need to perform the SR under the conditions that apply during a plant outage and the potential for an unplanned transient if the SR was performed with the reactor at power. The GE-FANUC and ASD system have high reliabilities for a nonsafety-related system with calculated failure probabilities of 1.25 E-06 and 4.26 E-06 per system demand, respectively. Since the independent and concurrent failure of both the GE-FANUC and ASD limiters is highly improbable, it is concluded that a 24 month frequency for the SR is acceptable from a reliability standpoint. Performance of the modified SR at the established frequency will maintain the ASDs within the limits assumed in the transient analyses and provides assurance that there will be no increase in the probability or consequences of a previously analyzed accident.

In addition to limiting the rate of change of flow to protect against flow increasing and decreasing events, the ASD design must also limit maximum core flow to protect against flow runout events. Maximum flow is limited by redundant and diverse maximum speed limiters which are contained in the GE-FANUC and ASD control logic along with the rate of change limiters. An overfrequency protection relay monitors the output of the ASD and will trip the RRC pump in the affected loop if the maximum speed limiters fail to maintain frequency increases less than the relay setpoint. The overfrequency protection design feature is analogous to the electrical and mechanical stops on the scoop tube positioner for motor-fluid-coupler generator sets used in BWR 3 and 4 plants. The electrical and mechanical stops on the motor-generator sets prevent the RRC pumps from exceeding pre-determined overspeed limits and are assumed to function in analyzed plant transients to ensure that Minimum Critical Power Ratio (MCPR) limits are not exceeded. For WNP-2, the ASD overfrequency protection relays ensure that MCPR limits are not exceeded by tripping the ASDs on an uncontrolled frequency increase in the highly unlikely event that both the GE-FANUC and the ASD maximum speed limiters fail. The MCPR limits are maintained in WNP-2 Technical Specification 3.2.3 and the COLR. Since the overfrequency relay settings can vary on a fuel cycle specific basis, it is proposed that the settings be maintained in plant procedures in lieu of Technical Specifications. The overfrequency relay settings can be adequately defined and controlled in plant procedures which require change control in accordance with 10CFR50.59. This approach provides an effective level of regulatory control and provides for a more appropriate change control process. NRC and Supply System resources associated with processing Technical Specification amendments will be reduced while having no impact on the probability or consequences of any previously analyzed accident. This is consistent with the approach taken in the BWR/4 Improved Technical Specifications (NUREG-1433) for the electrical and mechanical stops on their motor-generator sets.

Based on the above evaluation, it is concluded that the proposed Technical Specification amendment will not involve a significant increase in the probability or consequences of an accident previously evaluated.

2. *Does the change create the possibility of a new or different kind of accident from any accident previously evaluated?*

As described in the response to Question 1, the ASDs and new digital RFC system will provide variable frequency power to each RRC pump motor to vary the pump speed and, thereby, the system flow. Postulated ASD system component failures were examined to determine their consequences and to evaluate the capability of the plant to control or accommodate such failures. The events that could result from the postulated failures were analyzed and include anticipated operational occurrences, off-design abnormal transients that induce system operating condition disturbances, and postulated accidents of low probability. No new transients or accidents were identified during the analysis.

The potential worst-case malfunctions of the ASD system would result in flow increase or flow decrease transients no worse than the RRC pump trip, pump shaft seizure/break, and flow control failure transients previously analyzed in the WNP-2 Final Safety Analysis Report (FSAR). The design of the new digital RFC system includes maximum flow demand and rate of change limiters, automatic pump speed runbacks, and automatic pump trips that assure the RRC system flow will be controlled to maintain the analyzed fuel thermal margins under the various operating conditions.

Results of past reactor vessel internals vibration tests were evaluated to determine which components had natural frequencies in the ASD frequency range that might be adversely affected by variable speed operation of the RRC pump. The vibration tests examined included those conducted at WNP-2, at prototype BWR-5 plants, and at other plants which had reactor vessel internals identical or similar to WNP-2. This assessment identified the following critical reactor internal components which were subsequently analyzed in detail:

1. Jet Pumps
2. Shroud-Separator
3. Feedwater Sparger
4. Liquid Control/ΔP Line
5. Control Rod Guide Tube
6. Core Spray Line
7. In-Core Guide Tube
8. LPCI Coupling
9. Fuel
10. Steam Dryer
11. Jet Pump Sensing Lines

A detailed assessment of these components concluded that, with the exception of the jet pump sensing lines, the evaluated internals would withstand flow induced vibrations from the ASDs without exceeding acceptance criteria. Vibration tests were performed on the jet pump sensing lines to determine the natural frequencies and stresses that could occur as a result of ASD variable speed operation. A sinusoidal sweep frequency test was performed to determine the jet pump sensing line resonant frequencies. Dwell tests were performed for 3 minutes at each natural frequency to measure their response. The test results indicate that stresses in the bracket welds for the 20 jet pump sensing lines are high enough at resonant frequencies that mitigation devices (clamps) should be considered before the ASDs are operated above 15 Hz. The 15 Hz frequency value corresponds to low speed in the current two-speed (25% and 100%) mode of RRC pump operation. Installation of the clamps would change the natural frequency and prevent sensing line failure. Based on these findings, the Supply System will, as a minimum, clamp each jet pump sensing line sufficiently prior to initial ASD operation above 15 Hz to provide assurance that the RRC pumps can be operated at variable speed up to 1800 rpm (60 Hz ASD output frequency) for 3 years without any sensing line failures. The appropriate ASD operating limits will be imposed by plant operating procedures and ASD limiter setpoints. Additional clamps will be installed as necessary within 3 years to allow continued plant operation using the ASDs.

Subsequent to the above findings, the Supply System discovered a crack in the wall of jet pump sensing line #18 adjacent to and at the top of the weld joining the sensing line to the highest bracket on the jet pump diffuser. Analysis of the crack concluded that crack propagation was unlikely and continued plant operation was justified in the current two-speed mode of RRC pump operation. To allow plant operation following ASD implementation, the Supply System will install sufficient clamping on jet pump sensing line #18 prior to initial ASD operation above 15 Hz to prevent crack propagation during pump variable speed operation within the design limits.

Increased RRC system noise and vibration have been reported by some BWR 3 and 4 plants when they have increased RRC pump speed (NRC Information Notice 95-16). The plants reporting this condition have 5 blade RRC pump impellers, 251 inch reactor vessels, and RFC systems using motor-fluid-coupler generator sets that vary RRC pump speed. WNP-2 is a BWR 5 plant with 5 blade RRC pump impellers, a 251 inch vessel, and following ASD installation, the pump speed will be variable. As a result, analyses were performed for WNP-2 to determine the effects of increased pump speed and harmonics induced vibration on the RRC system pump, motor, and piping and the reactor internal components. Based on the results of these analyses, RRC system and reactor internals vibration are expected to remain within acceptable limits during variable and increased pump speed operation following ASD installation. As discussed above, specific action will be taken to mitigate potential increases in jet pump sensing line vibration. In addition, the Supply System will monitor large bore and small bore RRC system piping during initial ASD operation to assure vibration levels are acceptable. Administrative operating limits will be established if excessive vibration is detected.

The RFC system GE-FANUC digital equipment is to be installed in the main control room. The GE-FANUC equipment is designed and tested to perform in industrial environments. A baseline survey of the main control room environment was conducted with the reactor at power to determine the levels of EMI present. A review of the survey results confirmed that the GE-FANUC equipment will not be susceptible to the conducted and radiated noise over the entire signal spectra from 10 Hz to 100 Mhz (with margins of 26 and 48 dB, respectively). The review also showed that the equipment will have no impact on the electromagnetic environment in the control room.

Outside of the main control room, ASD low voltage control, diagnostic, alarm, and trip signals will be run in twisted shielded pair wiring within rigid ferrous conduit to resist the effects of EMI. To minimize the effects of EMI emissions from the ASDs on safety-related and balance of plant control systems, the ASDs are located in a separate building outside of the turbine building and the power cables to the RRC pump motor will be shielded and routed in accordance with proven cable separation criteria.

As described in Question 1, the proposed changes to the Technical Specifications update the requirements to reflect the change from a flow control valve design to an ASD design. Based on analyses, the ASD design change is expected to increase reliability and will not create any new transients or accidents. Most of the changes result in comparable requirements for the ASDs. The requirements being deleted will no longer be applicable following implementation of the ASD design change. The deactivation of the flow control valves and the elimination of the hydraulic system and associated containment isolation valves are expected to reduce the potential failure modes. Moreover, automatic controls included in the ASD design allow the deletion of previously required operator actions which will reduce the potential for error.

Based on the above evaluation, it is concluded that the proposed Technical Specification amendment will not create the possibility of a new or different kind of accident from any accident previously evaluated.

3. *Does the change involve a significant reduction in the margin of safety?*

As described in the response to Question 1, the ASDs and new digital RFC system will provide variable frequency power to each RRC pump motor to vary the pump speed and, thereby, the system flow. Analyses were performed to determine the impact of this design change on reactor core stability. Since the design change will permanently block open the flow control valves, flow control valve cavitation will no longer be an operational concern, thus allowing greater maneuverability in the low core flow region of the power to flow map. In addition, the ASD system does not require a shift from low speed (25%) to high speed (100%) as currently required by the flow control valve system. This will provide greater margin to the region of known lower stability. The ASD system will also allow the RRC pump speed to be increased along a lower flow control line that is farther from the stability exclusion region since the cavitation interlock is cleared at a lower power level. Therefore, due to the greater reactor power and flow maneuverability and the increased margin to regions of known low stability, power oscillations are less likely to occur during normal plant operation with the ASD system than with the existing flow control valve system.

The potential impact of the ASDs on containment and RRC system pressure containing components was evaluated. All stresses remain within allowable design limits and no detrimental effects were identified. Thus, the ASDs will have no impact on the existing containment analysis and will not adversely affect the RCPB.

As discussed in Question 2, the results of past reactor internals vibrations tests were also examined to determine which internal components had natural frequencies in the ASD frequency range that might be adversely affected by variable speed operation of the RRC pumps. The results indicate that stresses in the jet pump sensing line bracket welds are high enough at resonant frequencies that vibration mitigating clamps should be considered before the ASDs are operated above 15 Hz. As stated in Question 2, as a minimum each jet pump sensing line will be clamped sufficiently prior to initial ASD operation above 15 Hz to provide assurance that the RRC pumps can be operated at variable speed up to 1800 rpm (60 Hz ASD output frequency) for 3 years without any sensing line failures. The appropriate ASD operating limits will be imposed by plant operating procedures and ASD limiter setpoints. Additional clamps will be installed as necessary within 3 years to allow continued plant operation using the ASDs. The Supply System will also install sufficient clamping on jet pump sensing line #18 prior to initial ASD operation above 15 Hz to prevent crack propagation during pump variable speed operation within the design limits.

The RFC system does not perform any active safety-related functions. However, the system does have interlocks and setpoints that are intended to improve plant availability, prevent damage to equipment during transients, and mitigate plant transients. Setpoints quantify the abnormal operating condition values for which the speed of the RRC pumps should be runback to minimum (25% speed). The pump speed runback feature performs the same function as the existing automatic transfer from fast to slow speed. Most of the setpoints for the trip and runback features are determined from parameters and instruments in other systems, such as the loss of a feedwater pump signal, reactor vessel pressure and water level, or vessel steam dome temperature. These parameters are not affected by the RRC system and, therefore, would not change because of the ASDs. The only setpoint parameter for pump speed runback that is within the RRC system is RRC pump suction water temperature. The average suction temperature is compared with the vessel steam dome temperature to identify when the available pump net positive suction head (NPSH) is marginally low. The pump speed is runback when the differential temperature reaches 9.9°F (15 second time delay) to avoid pump cavitation. The ASDs will not affect the pump suction temperature measurement or the steam dome temperature (not an RRC system parameter) and, therefore, will not affect the setpoint.

There are four abnormal conditions or transients which cause the recirculation pumps to trip. Two of them, the suction or discharge valves <90% open and the pump motor or ASD protection logic actuated, are RRC system functions that are intended to protect equipment from damage by tripping the pumps. The ASDs will not impact these two trip functions. The other two conditions will open dedicated Recirculation Pump Trip (RPT) circuit breakers (3A, 3B, 4A, and 4B) in the pump drive motor power buses to augment the rate of power reduction for Anticipated Transient Without Scram (ATWS) and for generator load rejection with turbine trip events. The pumps are tripped during these two events to further assure that acceptable fuel thermal margins are maintained. The change to variable speed operation of the RRC pumps will impact RPT breaker performance and the RPT function since the RPT breakers are located between the ASDs and the pump motors. All four breakers are tripped on a generator load rejection with turbine trip signal. Two of the breakers (3A and 3B), one breaker for each pump, are tripped on ATWS signals (high reactor pressure or low water level). Breaker performance is usually characterized in terms of the number of cycles of the power supply that are needed to open the breaker and extinguish the arc. In this case, the RPT breaker performance is specified as less than or equal to 5 cycles of the power supply. Given the current non-variable 60 Hz power supply for the RRC pump motors, the arc suppression time was fixed at less than or equal to 83.3 milliseconds. Since the ASDs vary the frequency of the power supplied to the motor, the arc suppression time will vary inversely with the supplied frequency. For example, the opening time at 63 Hz would be 79.4 milliseconds [(60 Hz/63 Hz) x 83.3 milliseconds] and 100 milliseconds at 50 Hz [(60 Hz/50 Hz) x 83.3 milliseconds]. Since the safety analyses allow WNP-2 to operate at full power for a range of core flows, the effect of this variation in breaker opening time on the transient and accident analyses was evaluated. The evaluation concluded that the effect of the inclusion of the variable RPT delay in the transient analysis is not significant because the relative change of the RPT delay at 88% core flow or 106% core flow from the previous analysis assumption of 190 milliseconds is small.

The only impact on an ATWS event in changing from the existing flow control valve design to the ASD design results from the change in rate of recirculation flow coastdown following a RPT. Since the RRC pump and motor inertia have not changed, the change in coastdown would be due to differences in the RPT delay time, initial pump speed, and the recirculation line flow losses. The impact of the change in rate of recirculation flow coastdown on long term ATWS performance to control suppression pool heatup is expected to be insignificant since the change in the amount of steam directed to the suppression pool through the safety relief valves during an ATWS event would not change significantly. An assessment of the changes in initial pump speed and the recirculation line flow losses on a short term ATWS showed the peak vessel pressure to be 33 psi below the 1500 psig acceptance criteria. The approximate 10 millisecond additional RPT delay time at 88% core flow with the ASD design is estimated to increase peak vessel pressure by less than 2 psi during an ATWS event. Therefore, changing from the flow control valve design to the ASD design will have essentially no impact on an ATWS event and adequate margin to the ATWS acceptance criteria will be maintained.

As discussed in the response to Question 1, assessments of the impact of the change from a flow control valve design to an ASD design on ECCS performance and LOCA dose calculations were performed. It was concluded that the change to an ASD design will have a negligible effect on the ECCS performance analysis since the results are bounded by the existing SLO analysis which assumes no credit for performance of the RRC system. The SLO ECCS analysis results have substantial margin to the fuel PCT acceptance criterion of 2200°F. Since the ASDs do not change the inventory of material available for release during a LOCA, the ASDs will not affect the LOCA dose calculations or the margins to the 10CFR100 guidelines.

As discussed in the response to Question 2, the potential worst-case malfunctions of the ASD system would result in flow increase or flow decrease transients no worse than the RRC pump trip, pump shaft seizure/break, and flow control failure transients previously analyzed in the FSAR. The design of the new digital RFC system includes maximum flow demand and rate of change limiters, automatic pump speed runbacks, and automatic pump trips that assure the RRC system flow will be controlled to maintain the analyzed fuel thermal margins under the various operating conditions.

An analysis of the RFC failure - increasing flow event was performed for the ASD design change since an upscale failure in one or both loops of the RFC system can cause the core flow to increase. The RFC system design incorporates a master (two loop) controller as well as individual loop controllers. The event can be initiated by the instantaneous failure of a controller to its upper limits and the transient generally results in a reactor scram due to high neutron flux. The main difference between the postulated failure in one loop and two loops is the rate at which the controls allow the ASD to increase pump speed. The rate of speed change is limited by redundant and diverse speed demand limiters within the GE-FANUC and ASD control logic as well as the inherent inertia of the RRC pump and motor. The limiters are designed to function independently to prevent the demand signal from causing an unacceptable rate of speed change. The independent and simultaneous failure of both of these limiters in conjunction with a master controller failure is highly improbable. Thus, for the two loop controller failure event, the individual loop controllers are assumed to move at their maximum rate to increase pump speed in both RRC loops. For the one loop controller failure event, a failure in the ASD control logic is assumed causing the affected ASD to move at a higher than maximum rate to increase pump speed in one loop. Based on the results of the analyses, the RFC failure - increasing flow event will remain a non-limiting transient that does not challenge the RCPB or fuel margins.

The startup of an idle RRC pump will result in increased core flow and power. If started under normal conditions, the idle loop temperature will be no lower than 50°F below the operating loop temperature and the effect of this transient on surface heat flux and the Critical Power Ratio (CPR) is mild. However, the impact on fuel performance would be greater if the idle loop were filled with cold water. Since the RRC piping in each loop contains a large volume of water, improper startup of a loop filled with cold water would cause a power increase due to increased flow and increased subcooling. An analysis of the idle loop startup transient was performed for the ASD design change and new digital RFC system. The analysis assumed the idle loop to be filled with 100°F water and the pump speed and drive flow were increased to 100% of rated at the maximum speed controller demand rate. As was concluded for the RFC failure - increasing flow event, the abnormal startup of an idle loop event will also remain a non-limiting transient that does not challenge the RCPB or fuel margins.

As described in Question 1, the proposed changes to the Technical Specifications update the requirements to reflect the change from a flow control valve design to an ASD design. Most of the changes result in requirements that are comparable to existing requirements and maintain the current margin of safety. The proposed changes that delete the LCO and SR for operator action to place the flow controls in "manual" when one recirculation loop is not operating will not reduce any safety margins since the function will be performed automatically with the ASD design. This automatic feature is expected to enhance plant safety by reducing the potential for operator error. The proposed change that deletes the references to the hydraulic system containment isolation valves and their function serves only to update the Technical Specifications to the new plant configuration. This reduction in potential containment leakage paths is expected to increase containment effectiveness, which is likely to increase the margins to the 10CFR100 guidelines. The proposed changes also delete the SR to verify that the flow control valves fail "as is" on a loss of hydraulic pressure since the flow control valves are being deactivated and the associated hydraulic system components are being removed from the plant as part of the ASD design change. A SR to verify that the ASDs fail "as is" is not necessary because the most limiting failures result in increasing or decreasing flow transients that are bounded by the RFC failure - increasing flow and decreasing flow transient analyses. Thus, there will be no increase in transient severity or reduction in RCPB or fuel margins. Following implementation of the ASD design change, the ASD overfrequency protection relays will ensure that MCPR limits are not exceeded by tripping the ASDs on an uncontrolled frequency increase in the highly unlikely event that both the GE-FANUC and the ASD maximum speed limiters fail. The MCPR limits are maintained in WNP-2 Technical Specification 3.2.3 and the COLR and, since the overfrequency relay settings can vary on a fuel cycle specific basis, it is proposed that the settings be maintained in plant procedures in lieu of Technical Specifications. This is consistent with the approach taken in the BWR/4 Improved Technical Specifications (NUREG-1433) for the analogous electrical and mechanical stops on the motor-fluid-coupler-generator sets. The overfrequency relay settings will be controlled in accordance with 10CFR50.59 such that the margin of safety to the MCPR safety limit will not be affected.

Based on the above evaluation, it is concluded that the proposed Technical Specification amendment will not involve a significant reduction in a margin of safety.