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SUBJECT: Forwards addl supplemental info re request for amend to TSs on reactor recirculation sys adjustable speed drive upgrade.

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WASHINGTON PUBLIC POWER SUPPLY SYSTEM

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April 4, 1996
GO2-96-075

Docket No. 50-397

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

Gentlemen:

Subject: **WNP-2, OPERATING LICENSE NO. NPF-21 REQUEST FOR AMENDMENT TO TECHNICAL SPECIFICATIONS, REACTOR RECIRCULATION SYSTEM ADJUSTABLE SPEED DRIVE UPGRADE - ADDITIONAL SUPPLEMENTAL INFORMATION (TAC NO. M93949)**

References:

1. Letter GO2-96-051, dated March 12, 1996, JV Parrish (SS) to NRC, "Request for Amendment to Technical Specifications, Reactor Recirculation System Adjustable Speed Drive Upgrade - Supplemental Information (TAC NO. M93949)"
2. Letter, dated February 13, 1996, JW Clifford (NRC) to JV Parrish (SS), "Request for Additional Information for the Washington Public Power Supply System (WPPSS) Nuclear Project No. 2 (WNP-2) (TAC NO. M93949)"
3. Letter GO2-95-228, dated October 26, 1995, JV Parrish (SS) to NRC, "Request for Amendment to Technical Specifications, Reactor Recirculation System Adjustable Speed Drive Upgrade"

The purpose of this letter is to provide additional supplemental information to the Reference 3 request for amendment to the Technical Specifications. The 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. This letter and the attachments provide the additional information requested by the NRC staff.

Attachment 1 contains the detailed response to the staff question related to the tables provided in Appendix B, page 4, of the Reference 3 submittal. This attachment also includes three non-

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proprietary tables and excerpts from the GE Power System Harmonic Study for WNP-2 to support the response.

Attachment 2 contains the requested Electric Power Research Institute (EPRI) reports related to ASD testing, including the report for the EPRI sponsored testing conducted on the Southern California Edison Ormond Beach ASD retrofit project. Other non-proprietary information is also included for additional background on the Ormond Beach ASD application.

Attachment 3 contains the requested discussion of the ASD output filter capacitor failure modes, failure probabilities, and the associated effects.

Attachment 4 contains a discussion of the Supply System's evaluation of harmonics related heating of the nonsafety-related motor loads downstream of the SH-5 and SH-6 buses. This attachment also includes an excerpt from the applicable section of the National Electric Manufacturers Association (NEMA) MG-1-1987 Standard which served as the basis for the motor derating analysis performed for the SH-5 and SH-6 buses.

Should you have any questions or desire additional information regarding this matter, please call me or Lourdes Fernandez at (509) 377-4147.

Sincerely,

J. V. Parrish
Chief Executive Officer
(Mail Drop 1023)

CDM/my

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

STATE OF WASHINGTON)
)
COUNTY OF BENTON)

Subject: Request for Amendment to TS
Reactor Recirculation System ASD
Upgrade - Additional Information

I, J. V. PARRISH, being duly sworn, subscribe to and say that I am the Chief Executive Officer 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.

DATE 4/4, 1996

J. V. Parrish
Chief Executive Officer

On this date personally appeared before me J. V. PARRISH, 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 4 day of April 1996.

Notary Public in and for the
STATE OF WASHINGTON

Residing at Kennewick, WA

My Commission Expires 4/28/98

ATTACHMENT 1

Response to the staff question related to the Appendix B, page 4, tables of the Reference 3 submittal.

Question

Appendix B, page 4, of the Reference 3 submittal provides the results of an analysis in percentage of total harmonic distortion in startup as well as in the generation mode. Please explain these tables.

Response

To ensure a better understanding of the tables appearing in Appendix B, page 4, of the Reference 3 submittal, Tables 4.1, "Start-Up Mode," and 4.2, "Generation Mode," from the GE Power System Harmonic Study for WNP-2, dated November 1995, have been included in this attachment. These tables contain the complete data set compiled during the study whereas the tables in the submittal only contained the bounding data sets. The following explanation specifically applies to Tables 4.1 and 4.2, but is also applicable to the tables appearing in the Reference 3 submittal. Excerpts from the GE Harmonic Study relating to Tables 4.1 and 4.2 are also included in this attachment to provide additional background information.

The response of the WNP-2 electrical distribution system to the harmonic currents injected by the ASD equipment was evaluated under 44 different operating scenarios. As illustrated in Tables 4.1 and 4.2, analyses were performed for the startup and generation modes of plant operation. As described in the Reference 3 submittal, there are two ASDs installed at WNP-2 and each ASD incorporates two channels (A and B) which supply variable frequency power to a Loop A or B RRC pump. When both channels are operating in an ASD, the ASD is in 12-pulse mode. When only one channel (A or B) is operating in an ASD, the ASD is in 6-pulse mode. Column 1 (far left column) of Tables 4.1 and 4.2 indentifies the five different cases for each plant mode of operation (1S, 2S, 3S, 4AS, and 4BS for startup and 1G, 2G, 3G, 4AG, and 4BG for Generation). Column 2 (second column from left) indentifies the five different channel mode combinations for the two ASDs that were evaluated (AB-AB, A-AB, A-A, AB, and A).

For the channel modes with hyphens (Case Names 1S, 1G, 2S, 2G, 3S, and 3G), the channel(s) indicated before the hyphen are associated with the ASD that supplies the Loop A RRC pump and the channel(s) indicated after the hyphen are associated with the ASD that supplies the Loop B RRC pump. The channel mode designators for these cases are further described below:

Case Names 1S and 2S: The AB-AB designator represents the channel mode where Channels A and B of the ASD for the Loop A pump and Channels A and B of the ASD for the Loop B pump are operating. This would be the normal 12-pulse operating mode.

Case Names 2S and 2G: The A-AB designator represents the channel mode where only Channel A of the ASD for the Loop A pump is operating (6 pulse mode for Loop A) and both Channels A and B of the ASD for the Loop B pump are operating (12 pulse mode for Loop B). Note: The analytical results for Channel Modes B-AB, AB-A, and AB-B would be the same as those listed for Channel Mode A-AB.

Case Names 3S and 3G: The A-A designator represents the channel mode where only Channel A of each ASD is operating; thus, the RRC pumps in both Loops would be operating in 6-pulse mode. **Note:** The analytical results for Channel Mode B-B, A-B, and B-A would be the same as those listed for Channel Mode A-A.

For the channel modes without hyphens (Case Names 4AS, 4AG, 4BS, and 4BG), the channel mode designator refers to either the ASD that supplies the Loop A RRC pump or the ASD that supplies the Loop B RRC pump. The channel mode designators for these cases are further described below:

Case Names 4AS and 4AG: The AB designator represents the channel mode where both Channels A and B of either the ASD for the Loop A RRC pump or the ASD for the Loop B RRC pump are operating (12-pulse mode for the operating Loop). The ASD for the non-operating Loop is assumed to be shutdown.

Case Names 4BS and 4BG: The A designator represents the channel mode where only Channel A of either the ASD for the Loop A RRC pump or the ASD for the Loop B RRC pump is operating (6-pulse mode for the operating Loop). The ASD for the non-operating Loop is assumed to be shutdown. Note: The analytical results for Channel Mode B would be the same as those listed for Channel Mode A.

Column 3 (columns numbered from left) of Tables 4.1 and 4.2 indicates the percent Speed (100% speed = 1782 rpm) at which the total harmonic distortion voltage (THDv) and total harmonic distortion current (THDi) data were generated. The tables in Appendix B, page 4, of the Reference 3 submittal incorrectly labeled Column 3 as percent Load. Table 3.1, "Harmonic Current Injection Per Each ASD," from the GE Harmonic Study and the background discussion are included in this attachment to describe the relationship between the ASD speed and load current.

Column 4 of Tables 4.1 and 4.2 indicates the THDv values at the associated channel modes and percent speeds that could be expected on the 6.9 KV SH-5 and SH-6 electrical buses (nonsafety-related power supply for the ASDs). In the startup mode of operation, the SH-5 and SH-6 buses are powered from the X winding of the TR-S startup transformer. In the generation mode of operation, these buses are powered from the TR-N2 normal auxiliary transformer.

Columns 5, 6, and 7 of the tables indicate the THDv values at the associated channel modes and percent speeds that could be expected on the 4.16 KV SM-1, SM-2, and SM-3 electrical buses (safety-related bus power supplies), respectively. In the startup mode of operation, the SM-1, SM-2, and SM-3 buses are powered from the Y winding of the TR-S startup transformer. In the generation mode of operation, these buses are powered from the TR-N1 normal auxiliary transformer.

Column 8 of Table 4.1 indicates the THDv values at the associated channel modes and percent speeds that could be expected on the primary (230 KV) winding of the TR-S startup transformer during the startup mode of operation.

Column 8 of Table 4.2 indicates the THDv values at the associated channel modes and percent speeds that could be expected on the secondary (25 KV) winding of the TR-M1 main step-up iso-phase transformer (also applies to the other two phase transformers (TR-M3 and TR-M4)) and on the primary winding of the TR-N1 normal auxiliary transformer during the generation mode of operation. The TR-N1 normal auxiliary transformer secondary windings (two secondary windings) supply the SM-1, SM-2 and SM-3 buses in the generation mode. The TR-N2 normal auxiliary transformer secondary winding supplies the SH-5 and SH-6 buses in the generation mode. Thus, as discussed in the Reference 1 and 3 submittals, the SM-1, SM-2, and SM-3 buses (supply safety-related loads) and the SH-5 and SH-6 buses (supply nonsafety-related loads) are normally powered from separate transformers with no direct electrical interface. This electrical separation results in the low THDv values expected on the SM-1, SM-2, and SM-3 buses and their respective safety-related loads in the generation mode.

The last three columns of Table 4.1 indicate the total harmonic distortion current (THDi) values at the associated channel modes and percent speeds that could be expected on the TR-S transformer X, Y, and H windings during the startup mode of operation. The last three columns of Table 4.2 indicate the THDi values at the associated channel modes and percent speeds that could be expected on the TR-N2 normal auxiliary transformer secondary winding, the TR-N1 normal auxiliary transformer primary winding, and the TR-M (TR-M1, TR-M3, and TR-M4) step-up transformer primary windings. These last three columns are further explained in the Reference 1 response to Question 9. Note: The TR-M column (last column) was incorrectly identified in the Reference 1 submittal as containing the THDi data analyzed for the TR-M secondary windings. This data is actually for the TR-M primary windings as stated above.

As discussed during the March 26, 1996 telephone conference call with the staff, the ASDs would normally be operated a 25 percent speed (15 Hz) in the startup mode before the plant electrical distribution system is transferred to the generation mode. As a result, the startup mode THD values would be approximately those listed in Table 4.1 for 20 percent speed. Thus, in the startup mode of operation, the highest THDv value expected on the SH-5 and SH-6 buses is 2.5 percent and only 0.1 percent on the SM-1, SM-2, and SM-3 buses. These THDv values are within the 5 percent maximum recommended in Institute of Electric and Electronics Engineers (IEEE) Standard 519 - 1993.

Note: The attached information from the GE Harmonic Study refers to a maximum speed of 20 percent in the startup mode. The normal speed in the startup mode is 25 percent as stated in the above discussion.

3.1 Harmonic Current Injection

The magnitudes of the harmonic current components "injected" by the ASD units are related to the drive speed. As the drive speed and fundamental component of load current increase, the magnitudes of the lower harmonic components also tend to increase. Some of the higher frequency components reach maximum values at intermediate load levels, but the majority of the harmonic current components are greatest at full load.

Table 3.1 shows the harmonic currents injected into the 6.9 kV bus by each ASD unit for a variety of drive speeds and for 6-pulse and 12-pulse operating modes. Since the separate ASD units are located at different points within the electrical distribution system and operate independently, the harmonic currents generated by the separate drives will not in all cases occur at the same phase angle. As the separate currents combine in the power system, they will add vectorily and some degree of cancellation may be expected to occur. For the purpose of this study, it is assumed that the harmonic currents injected by the separate drives are actually in phase and add arithmetically. This assumption leads to a conservative calculation of the total harmonic distortion (THD) since cancellation due to unequal phase angles is ignored.

This study investigates the distribution system harmonic distortion as function of both the drive speed and whether the drives are operating in 6-pulse, 12-pulse or a combination of 6-pulse and 12-pulse.

For 6-pulse operation, the maximum drive speed is 76.5%. For the purpose of this harmonic analysis, it is assumed that the harmonic current injections at 76.5% correspond with those of the 80% speed 12-pulse mode. So, when one ASD unit is operating in 12-pulse operation at 80% speed, the other ASD unit is operating at 76.5% speed in 6-pulse mode.

The harmonic current injections will be greatest at the 5th harmonic and then the 7th and so on for 6-pulse operation since no phase cancellation will occur as in the 12-pulse mode of operation. Likewise, for 12-pulse operation, the 5th and 7th harmonic current injections are less than the 11th and 13th harmonic current injections due to phase cancellation, while the 11th and 13th are greater due to no phase cancellation.

For the purpose of this study, it was important to look at both modes of operation to ensure that the greatest harmonic distortion possible was reported. Harmonic filters must be sized and rated to carry the maximum possible harmonic currents injected into the system by the ASD Units.

Table 3.1
Harmonic Current Injection per Each ASD

12-Pulse Mode (A and B Channels On)

Amp Rate	978.985	@6.9 kV			
	Speed %				
	100	80	60	40	20
H_n	Amps	Amps	Amps	Amps	Amps
1	978.99	587.39	303.49	166.43	166.43
5	19.29	11.81	6.16	3.40	3.40
7	13.02	8.22	4.25	2.33	2.33
11	78.61	52.87	28.25	15.76	15.76
13	58.93	41.47	22.34	12.18	12.18
17	4.11	3.29	1.85	1.03	1.03
19	3.03	2.64	1.49	0.82	0.82
23	20.95	22.67	13.57	7.79	7.79
25	14.39	17.92	10.90	5.97	5.97
THDi	10.65	12.71	13.43	13.59	13.59

6-Pulse Mode (A or B Channel Mode On)

Ibase	489.493	@6.9 kV		
	Speed %			
	76.5	60	40	20
H_n	Amps	Amps	Amps	Amps
1	489.49	318.17	220.27	97.90
5	97.12	64.40	44.74	19.99
7	65.84	44.29	30.82	13.67
11	40.82	29.21	20.53	9.26
13	31.03	22.94	16.17	7.18
17	22.57	18.61	13.35	6.10
19	17.13	14.86	10.73	4.78
23	12.87	13.33	9.85	4.57
25	9.40	10.56	7.86	3.52
THDi	26.99	28.71	29.02	29.20

Section 4

HARMONIC ANALYSIS AND RESULTS

To evaluate the effects of injected harmonic currents on the WNP-2 Plant electrical distribution system, a computer based harmonic analysis was performed. The analysis method basically determined the harmonic current flows and bus voltages using a system of nodal admittance equations. Ideal voltage or current sources at individual frequencies represented harmonic sources. Inductance's, capacitance's and transformers were assumed to be ideal elements within the frequency range of interest. Eddy current factors were employed in modeling the resistance's of each type of device. The solution of multiple source systems used the superposition principle disregarding phase angle relationships. Thus, the current or voltage distortion at any point is the algebraic sum of the distortion due to each source. This rendered the calculation method conservative. Actual measurements are expected to be less than the calculated values. However, this method is a valid means of assessing the boundaries of the harmonic performance of an actual power system. The following equations are useful in assessing the extent of harmonic current and voltage distortion.

$$THD_v = \sqrt{\sum_h V_h^2} \Big/ V_1$$

$$I_{rss} = \sqrt{\sum_h I_h^2} \Big/ I_1$$

$$V_{sum} = \sum_h I_h \bullet Z_h$$

Where:
h = 2 to n
V_h = Voltage @ Harm. Order h
I_h = Current @ Harm. Order h
Z_h = Impedance. @ Harm. Order h

The response of the electrical distribution system to the harmonic currents injected by the ASD equipment was evaluated under forty-four (44) different operating scenarios. As illustrated in Tables 4.1 and 4.2, analyses were performed under two (2) plant modes of operation (see Figure 3.1 and 3.2). Although plant procedures do not allow operation in the start-up mode at greater than 20% speed, harmonic distortions for the entire speed range were calculated for information. Under each mode of operation, five combinations of drive channel modes were evaluated. For each drive channel mode, five ASD speeds (20, 40, 60, 80 & 100 %) were evaluated. Tables 4.1 and 4.2 summarize the conditions and key results of each scenario. The output for each scenario is provided in Appendix-1.

Table 4.1

Start-Up Mode
WNP-II Harmonic Study Results

CASE NAME	CHANNEL MODES	Speed %	THDv SH5/SH6 6.9kv	THDv SM1 4.16kv	THDv SM2 4.16kv	THDv SM3 4.16kv	THDv 230 Kv BUS	THDi TRS-X	THDi TRS-Y	THDi TRS-H
1S	AB-AB	100	9.9	0.5	0.5	0.5	0.8	19.4	1.4	5.4
1S	AB-AB	80	7.9	0.4	0.4	0.4	0.4	13.4	1.0	3.8
1S	AB-AB	60	4.5	0.2	0.2	0.2	0.4	7.3	0.5	2.1
1S	AB-AB	40	2.5	0.1	0.1	0.1	0.2	4.1	0.3	1.1
1S	AB-AB	20	2.5	0.1	0.1	0.1	0.2	4.1	0.3	1.1
2S	A-AB	80	7.5	0.4	0.4	0.4	0.6	16.7	1.2	4.7
2S	A-AB	60	5.1	0.3	0.3	0.3	0.4	10.9	0.8	3.0
2S	A-AB	40	3.3	0.2	0.2	0.2	0.3	7.2	0.5	2.0
2S	A-AB	20	2.1	0.1	0.1	0.1	0.2	4.2	0.3	1.2
3S	A-A	80	8.2	0.4	0.4	0.4	0.7	23.8	1.7	6.6
3S	A-A	60	6.4	0.3	0.3	0.3	0.5	16.4	1.2	4.6
3S	A-A	40	4.6	0.2	0.2	0.2	0.4	11.5	0.8	3.2
3S	A-A	20	2.1	0.1	0.1	0.1	0.2	5.1	0.4	1.4
4AS	AB	100	4.9	0.2	0.2	0.2	0.4	9.4	0.7	2.6
4AS	AB	80	4.0	0.2	0.2	0.2	1.9	6.7	0.5	1.9
4AS	AB	60	2.2	0.1	0.1	0.1	0.2	3.7	0.3	0.1
4AS	AB	40	1.2	0.1	0.1	0.1	0.1	2.0	0.1	0.6
4AS	AB	20	1.2	0.1	0.1	0.1	0.1	2.0	0.1	0.6
4BS	A	80	4.1	0.2	0.2	0.2	0.4	11.9	0.8	3.3
4BS	A	60	3.2	0.2	0.2	0.2	0.3	8.2	0.6	2.3
4BS	A	40	2.3	0.2	0.2	0.2	0.3	8.2	0.6	2.3
4BS	A	20	1.0	0.1	0.1	0.1	0.1	2.6	0.2	0.7

THDi Base on the Following

TRS-X - 1000Amp @ 6.90 kV
TRS-Y - 500Amp @ 4.16 kV
TRS-H - 105Amp @ 230 kV

Table 4.2

Generation Mode

WNP-II Harmonic Study Results

CASE NAME	CHANNEL MODES	Speed %	THDv SH5/SH6 6.9 kv	THDv SM1 4.16 kv	THDv SM2 4.16kv	THDv SM3 4.16 kv	THDv TR-M1 & N1 25 kv	THDi TR-N2 (TRN2)	THDi TR-N1-Primary	THDi TR-M (TRM)
1G	AB-AB	100	8.2	0.2	0.2	0.2	0.3	14.3	0.2	0.1
1G	AB-AB	80	6.6	0.2	0.2	0.2	0.2	10.3	0.1	0.1
1G	AB-AB	60	3.7	0.1	0.1	0.1	0.1	5.6	0.1	0.0
1G	AB-AB	40	2.1	0.1	0.1	0.1	0.1	3.1	0.1	0.0
1G	AB-AB	20	2.1	0.1	0.1	0.1	0.1	3.1	0.1	0.0
2G	A-AB	80	6.2	0.2	0.2	0.2	0.2	12.7	0.2	0.1
2G	A-AB	60	4.3	0.1	0.1	0.1	0.1	8.3	0.1	0.1
2G	A-AB	40	2.8	0.1	0.1	0.1	0.1	5.5	0.1	0.0
2G	A-AB	20	1.8	0.1	0.0	0.0	0.1	3.2	0.1	0.0
3G	A-A	80	6.9	0.2	0.2	0.2	0.2	18.1	0.3	0.1
3G	A-A	60	5.3	0.2	0.1	0.1	0.2	12.5	0.2	0.1
3G	A-A	40	3.8	0.1	0.1	0.1	0.1	8.7	0.2	0.1
3G	A-A	20	1.7	0.0	0.0	0.0	0.1	3.9	0.1	0.0
4AG	AB	100	4.1	0.1	0.1	0.1	0.1	7.2	0.1	0.0
4AG	AB	80	3.3	0.1	0.1	0.1	0.1	5.1	0.1	0.0
4AG	AB	60	1.9	0.1	0.0	0.0	0.1	2.8	0.0	0.0
4AG	AB	40	1.0	0.0	0.0	0.0	0.0	1.6	0.0	0.0
4AG	AB	20	1.0	0.0	0.0	0.0	0.0	1.6	0.0	0.0
4BG	A	80	3.4	0.1	0.1	0.1	0.1	9.0	0.1	0.1
4BG	A	60	0.1	0.1	0.1	0.1	0.1	6.3	0.1	0.0
4BG	A	40	1.9	0.1	0.0	0.0	0.1	4.4	0.1	0.0
4BG	A	20	0.9	0.0	0.0	0.0	0.0	2.0	0.0	0.0

THDi Base on the Following

- TR-N2 - Secondary 1355Amp @ 6.90 kV
- TR-N1 Primary - 254 Amp @ 25kV
- TR-M Primary - 1254Amp @ 525 kV

Tables 4.1 and 4.2 show the expected total harmonic distortion of various bus voltages (THDv) which can be compared with levels recommended in IEEE Std. 519 - 1993. The standard has been developed to establish guidelines concerning the distortion of system voltage and current waveforms due to the behavior of non-linear load devices. The standard primarily concerns itself with conditions at the point of common coupling (PCC) between an industrial customer and the local utility system. Within an industrial plant, the PCC is considered to be the point between the non-linear load and other loads. For the purposes of this study, the PCC is considered to be the 6.9 kV, SH-5 and SH-6 buses supplying the given ASDs. Due to the close electrical proximity of the SH-5 and SH-6 buses, the THDv at each bus are identical.

The standard recommends that the THDv at a general purpose bus be maintained at or below 5% while 10% THDv may be allowed at a bus serving solid state drive equipment. These limits are not analytically derived, but are based upon many years' experience within the electrical industry.

Table 4.1 summarizes the results of the harmonic analysis assuming the ASDs are operating at speeds of 100%, 80%, 60%, 40%, and 20% while the distribution system is configured in the start-up mode. As seen in the table, the THDv at the SH-5 and SH-6, 6.9 kV buses is expected to exceed 5% for drive speeds near 50% for some channel modes of operation. The greatest THDv expected (9.9%) on SH-5 and SH-6 occurred for drive speeds of 100% with the drives operating in AB mode (12-pulse equivalent mode). THDv levels associated with the Emergency Auxiliary system, 4.16kV buses SM1, SM2, and SM3 are not expected to be greater than 0.5%. This is due to the electrical isolation that is provided by the source and supply transformers of the system. Since the ASDs would only be operated at 20% speed in the start-up mode, the highest THDv would be 2.5% on the SH-5 and SH-6 buses and 0.1% on the SM1, SM2 and SM3 buses.

Table 4.2 summarizes the results of the harmonic analysis assuming the ASDs are operating at speeds of 100%, 80%, 60%, 40%, and 20% while the distribution system is configured in generation mode. As seen in the table, the THDv at the SH5 and SH6 6.9 kV buses is expected to exceed 5% for drive speeds near 60% for some channel modes of operation. The greatest THDv expected (8.2%) on SH5 and SH6 occurred for drive speeds of 100% with the drives operating in AB mode (12-pulse equivalent mode). THDv levels associated with the Emergency Auxiliary system, 4.16kV buses SM1, SM2, and SM3 are not expected to be greater than 0.2%.

The THDv levels expected in generation mode are slightly less than those expected in the corresponding start-up mode. This is due to the difference in the source impedance of the system. The source impedance is greater under the start-up mode and as.a consequence its associated THDv levels are slightly higher.

It must be remembered that the preceding analysis is conservative. Variability introduced by system damping effects and harmonic source phase angle relationships should result in lower harmonic distortion levels than those predicted herein. Although the IEEE recommendations concerning bus voltage distortion are only meant to apply at the point of common coupling between a static load and power supply system, WNP-2 does not intend to apply the 5% guideline throughout the plant distribution system due to the nature of the load where distortions are greater than 5%. It was conveyed by WNP-2 that the load fed from bus SH-5 and SH-6 are primarily comprised of motor load.

ATTACHMENT 2

EPRI reports related to ASD testing, including the Ormond Beach test report and other background information.