CATEGORY 1

REGULATORY INFORMATION DISTRIBUTION SYSTEM (RIDS)

ACCESSION NBR:9605130294 DOC.DATE: 96/05/08 NOTARIZED: YES DOCKET #
FACIL:50-397 WPPSS Nuclear Project, Unit 2, Washington Public Powe 05000397
AUTH.NAME AUTHOR AFFILIATION
PARRISH,J.V. Washington Public Power Supply System
RECIP.NAME RECIPIENT AFFILIATION
Document Control Branch (Document Control Desk)

SUBJECT: Submits formalize responses provided verbally to NRC in discussions conducted on 960425 re reactor recirculation sys adjustable speed drive upgrade.

DISTRIBUTION CODE: A001D COPIES RECEIVED:LTR 1 ENCL 1 SIZE: 13
TITLE: OR Submittal: General Distribution

NOTES:

	RECIPIENT ID CODE/NAME	COPIES LTTR	COPIES ENCL	RECIPIENT ID CODE/NAME	COPIES LTTR	COPIES ENCL
	PD4-2 LA	1	1	PD4-2 PD	1	1
	COLBURN,T	1	1			
INTERNAL:	ACRS	6	6	FILE CENTER 01	1	1
	NRR/DE/EMCB	1	1	NRR/DRCH/HICB	1	1
	NRR/DSSA/SPLB	1	1	NRR/DSSA/SRXB	1	1
	NUDOCS-ABSTRACT	1	1	OGC/HDS3	1	0
EXTERNAL:	NOAC	1	1	NRC PDR	1	1

CATEGORY 1 DOCUMENT

NOTE TO ALL "RIDS" RECIPIENTS:
PLEASE HELP US TO REDUCE WASTE! CONTACT THE DOCUMENT CONTROL DESK, ROOM OWFN 5D-5(EXT. 415-2083) TO ELIMINATE YOUR NAME FROM DISTRIBUTION LISTS FOR DOCUMENTS YOU DON'T NEED!

TOTAL NUMBER OF COPIES REQUIRED: LTTR 18 ENCL 17

WASHINGTON PUBLIC POWER SUPPLY SYSTEM

P.O. Box 968 • 3000 George Washington Way • Richland, Washington 99352-0968 • (509) 372-5000

May 8, 1996
GO2-96-098

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 GO2-96-075, dated April 4, 1996, JV Parrish (SS) to NRC, "Request for Amendment to Technical Specifications, Reactor Recirculation System Adjustable Speed Drive Upgrade - Additional Supplemental Information (TAC NO. M93949)"

2. 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)"

3. 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)"

4. 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 formalize responses provided verbally to the NRC in discussions conducted on April 11 and April 25, 1996 with regard to the expected effects of power system harmonics on the equipment connected to the nonsafety-related 6.9 kV SH-5 and SH-6 buses at

A001 1/1

WNP-2. The equipment on the safety-related buses and the other nonsafety-related 4.16 kV buses will not be affected by the harmonics since the levels on these buses are expected to have a total harmonic distortion voltage (THDv) of less than 0.5%.

During reverification of the transformer loading calculations, it was noted that the maximum load values specified for the ASDs and the TR-S (Startup) and TR-N2 (Normal) transformers were incorrect. Since ASD loading affects the harmonic content, the transformer harmonic derating factors were also affected. As a result, some of the transformer data presented in this submittal is different than was previously provided verbally and by facsimile (FAX).

It should be noted that various standards are referenced below and, in general, the standards fall into three classifications: 1) power system requirements, 2) harmonic current effects on equipment, and 3) power transformer loading guidelines. Institute of Electrical and Electronic Engineers (IEEE) Standard 519 is a power system standard directed at manufacturers of static power converters and users of systems with static power converters. Its primary purpose is to limit unwanted harmonics to prevent the power system from adversely affecting consumer equipment. American National Standards Institute (ANSI)/IEEE C57.110 and National Electric Manufacturers Association (NEMA) MG-1 are equipment standards that focus on the effects of harmonics on transformers and motors, respectively. ANSI/IEEE Standard C57.92 provides guidance for establishing power transformer loading profiles. Since power transformers are low impedance devices and harmonic current transmission within the plant distribution system is inversely proportional to impedance, harmonic current and its heating affects are the limiting parameters for the transformers. Similarly, since the motors are higher impedance devices, the harmonic current is less dominant and the harmonic voltage is of primary importance in evaluating motor heating effects.

An analysis was performed to determine the effects of ASD related harmonics on the nonsafety-related equipment connected to the SH-5 and SH-6 buses. The results of this analysis are conservative for a number of reasons. First, the analysis assumes that all ASD harmonic contributions are in phase and additive rather than random. Second, rather than using the lower harmonic values associated with the 480 V buses, the 480 V motors connected downstream of the SH-5 and SH-6 buses were evaluated for harmonics heating effects using the maximum harmonic value expected at the SH-5 and SH-6 buses (9.9% THDv) when connected to the TR-S transformer. It was assumed that the ASDs were operating at 100% speed with power supplied by the TR-S transformer - the ASDs would not normally be operating above 50% speed while connected to the TR-S transformer. Finally, the analysis assumes the ASDs are operated at the unit rating of 11,200 HP rather than the maximum (63 Hz) RRC pump load of 9,502 HP. A change in horsepower rating from 11,200 HP to 10,000 HP alone changes the calculated maximum Generation Mode THDv level at the SH-5 and SH-6 buses from 8.2% to 7.0%, with a corresponding reduction at the 480 V buses from 6.5% to 5.5% when connected to the TR-N2 transformer (see Attachment 1).

The equipment of concern are the 480 V motors connected downstream of the SH-5 and SH-6 buses, and the startup and normal supply transformers (TR-S and TR-N2, respectively), which supply power to the SH-5 and SH-6 buses. Based on the 11,200 HP ASD rating at 100% drive

speed, the THDv values at the SH-5 and SH-6 buses may reach as high as 8.2% when connected to the TR-N2 transformer, or 9.9% when connected to the TR-S transformer (see Attachment 1 and Tables 4.1 and 4.2 of Reference 1). Under these conditions the expected THDv values at the point of common coupling (PCC) (the consumer-utility interface) are within the 5% THDv value recommended by IEEE Standard 519 for continuous operation. However, the THDv values at the SH-5 and SH-6 buses and the connected 480 V buses could exceed 5%. The primary loads connected to these buses are 480 V motors. Based on analysis, these 480 V motors would actually be exposed to THDv values less than those calculated for the SH-5 and SH-6 buses (i.e., 6.5% at the 480 V bus vs. 8.2% at the SH-5 and SH-6 buses in the Generation Mode at 100% speed). As previously addressed in the Reference 1 submittal and reiterated later in this submittal, even THDv values of the magnitude calculated for the SH-5 and SH-6 buses will not result in excessive harmonic related motor heating and no derating of the 480 V motors is necessary.

TRANSFORMERS

Since the TR-S and TR-N2 transformers are low impedance devices and must transfer the harmonic currents produced by the ASDs through the PCC, additional harmonic current related heating will result. This additional heating will effectively reduce the nameplate rating of the transformers due to winding temperature limitations. The primary effect of power system harmonics on transformers is the additional heat generated by the losses caused by the harmonic content of the load current. When high harmonic load current magnitudes are transformed, additional heat is generated in the transformer which may require load capability derating to remain within the transformer temperature rating. The primary loss components are winding I^2R losses, winding eddy-current losses, and stray losses. The I^2R loss component is attributed to conductor heating and the skin effect (concentration of current flow near the surface of a conductor causing an increase in resistance). Eddy (circulating) currents in the transformer windings result in losses that increase with the square of the load current and the square of the frequency. Stray losses are eddy-current losses due to stray electromagnetic flux in the windings, core, core clamps, magnetic shields, tank walls, and other structural components of the transformer. Whether derating is needed depends on the rating of the transformers versus the operating loads and the additional heating caused by the harmonic currents.

Several IEEE standards provide guidelines on transformer loading and capability. The loading guidance contained in these standards is based on the harmonic load current distortion factor limit of 5% (HLF) recommended in ANSI/ANSI Standard C57.1200-1987, "General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers," and IEEE Standard C57.12.01-1989, "General Requirements for Dry-Type Distribution and Power Transformers Including Those With Solid Cast and/or Resin-Encapsulated Windings." However, ANSI/IEEE Standard C57.110-1986, "Recommended Practice for Establishing Transformer Capability When Supplying Non-Sinusoidal Load Currents," recognizes that load currents, in many cases, exceed the HLF limit of 5%. As a result, this standard provides uniform methods for determining the capability of transformers to supply nonsinusoidal load currents. Since the the TR-S and TR-N2 transformers must carry additional harmonic currents during ASD operation, ANSI/IEEE Standard C57.110-1986 has been applied to the TR-S and TR-N2 transformers to determine if transformer derating was necessary. Based on the guidance

provided in the standard, a reduction in the transformer ratings was required to reflect the additional heating and associated temperature rise caused by the harmonic currents. The calculated derating factors are 4.47% and 9.43% for the TR-S and TR-N2 transformers, respectively. The TR-S derating is based on a single ASD operating at 100% (60 Hz) drive speed. This bounds the condition of two ASDs operating at 50% drive speed. The TR-N2 derating is based on two ASDs operating at 105% (63 Hz) drive speed. Plant specific harmonic levels will be obtained during power ascension following the Spring 1996 refueling outage (R-11) and will be used to recalculate the derating factors for the TR-S and TR-N2 transformers in accordance with ANSI/IEEE Standard C57.110-1986.

Ambient temperature, short time loading, and rated KVA (kilovolt-amperes) are among the factors used to evaluate transformer operation. ANSI/IEEE Standard C57.92-1981, " Guide for Loading Mineral-Oil-Immersed Power Transformers Up to and Including 100 MVA with 55°C or 65°C Average Winding Rise," provides guidance for establishing loading profiles based on these operating factors. Using this guidance, it was determined that ASD loading must be limited while powered from the TR-S transformer at its derated capability. Consequently, the ASDs will be restricted to two ASD operation at 50% speed or one ASD operation at 100% speed while connected to the TR-S transformer. The TR-N2 transformer is expected to be within its derated capability and no limitations on ASD or transformer operation should be necessary for TR-N2.

As previously stated, plant specific harmonic levels obtained during R-11 power ascension testing will be used to recalculate the derating factors for the TR-S and TR-N2 transformers. These recalculated derating factors will be evaluated to establish the final plant specific transformer derating factors and operational limits for the TR-S and TR-N2 transformers in accordance with normal station practice and ANSI/IEEE Standards C57.110-1986 and C57.92-1981.

MOTORS

Nonsinusoidal voltages applied to rotating electric machines can cause overheating, pulsating torque, or noise if excessive levels exist. Rotor overheating is usually the main concern associated with excessive THDv levels. Losses or heat generated in electric machines depends upon the frequency of the applied voltage. NEMA Standard MG-1-1987, "Motors and Generators," Part 17A, addresses motor application considerations for constant speed motors used on a sinusoidal bus with harmonic content. For this application, the standard assigns a derating factor for induction motors based on the calculated Harmonic Voltage Factor (HVF) and the use of Figure 17A-1 (see Attachment 4 of Reference 1). The HVF is defined as follows:

$$HVF = (\Sigma(Vn)^2/N)^{0.5}$$

Where: n = order of odd harmonic, not including those divisible by three
Vn = the PU magnitude of the voltage at the nth harmonic frequency

To reduce the possibility of damage to motors, the standard recommends that the rated horsepower of the motor be multiplied by the factor shown in Figure 17A-1. Based on the results of the harmonic analysis, the HVF for the 6.9 kV SH-5 and SH-6 buses for 100% drive speed in the Startup Mode is calculated to be 0.02779. The derating factor for this HVF (obtained from the table) is 1.0, which corresponds to the nameplate rated horsepower of the motor. In other words, no derating of the motor is required with the expected THDv levels.

CONCLUSIONS

1. The THDv values for the safety-related buses are less than 0.5% for all modes of operation.

2. Harmonic distortion at the PCC remains within acceptable limits.

3. No motor derating is necessary for the motors connected to the SH-5 and SH-6 buses.

4. The forced air (FA) rating of the TR-S transformer requires a derating of 4.47% from its nameplate capability for one ASD operation at 100% drive speed. This operating mode bounds two ASD operation at 50% drive speed. ASD operation while connected to the TR-S transformer will be restricted to two ASD operation at a maximum drive speed of 50% or single ASD operation at a maximum drive speed of 100%. The derating factors for the TR-S transformer will be recalculated using plant specific harmonic levels obtained during R-11 power ascension testing. These recalculated derating factors will be evaluated to establish the final plant specific transformer derating factors and operational limits for the TR-S transformer.

5. The FA rating of the TR-N2 transformer requires a derating of 9.43% from its nameplate capability for 105% drive speed. The derating factors for the TR-N2 transformer will be recalculated using plant specific harmonic levels obtained during R-11 power ascension testing. These recalculated derating factors will be evaluated to establish the final plant specific transformer derating factors and operational limits for the TR-N2 transformer.

Attachment 1 is a non-proprietary single-line electrical diagram containing harmonics data (in percent) calculated for the Generation Mode assuming a RRC pump load of 11,200/10,000 HP (actual maximum pump load is 9,502 HP).

Attachment 2 includes a revised "Transformer Loading Summary Table" and revised Tables 6.1, "TR-N2 Transformer Harmonic Derating Factor" and 6.2, "TR-S Transformer Harmonic Derating Factor."

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/cdm

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: Amendment to Technical Specifications Reactor Recirculation System Adjustable Speed Drive Upgrade - Additional Supplemental 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 8 May, 1996

J. V. Parrish
Chief Executive Officer

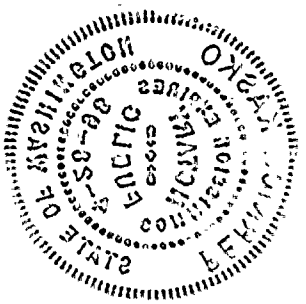
On this date personally appeared before me J. V. PARRISH, to me known to be the individual who executed the foregoing instrument, and acknowledged that he signed the same as his free act and deed for the uses and purposes herein mentioned.

GIVEN under my hand and seal this 8 day of May 1996.

Notary Public in and for the
STATE OF WASHINGTON

Residing at Kennewick WA

My Commission Expires 4/28/98

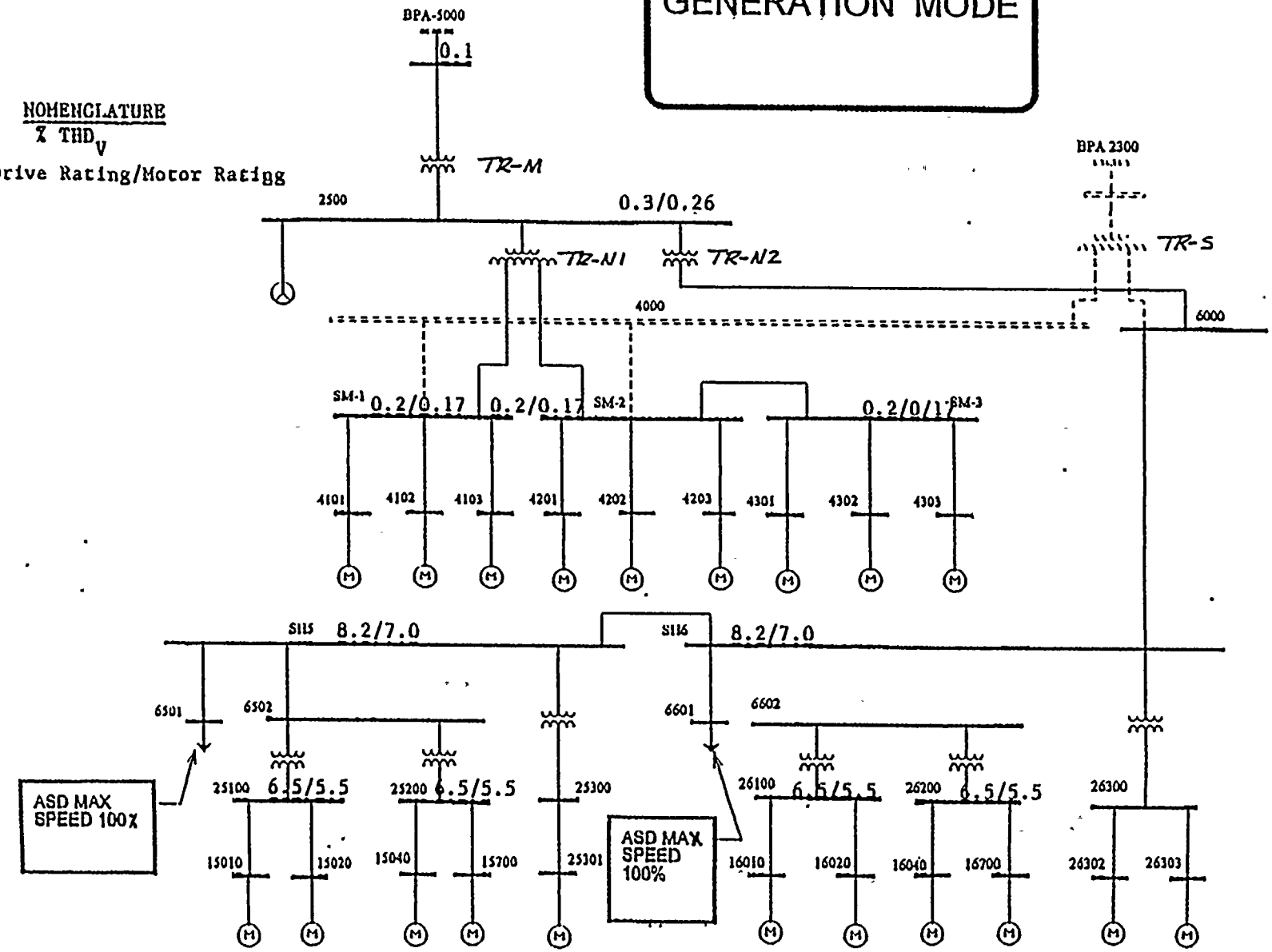


ATTACHMENT 1

Single-Line Electrical Diagram with 11,200/10,000 HP Harmonics Data (%)

GENERATION MODE

NOMENCLATURE
% THD_V
Drive Rating/Motor Ratigg



ATTACHMENT 2

Transformer Loading Summary and Derating Factor Tables

Transformer Loading Summary Table

Transformer	% Speed	Rating Amps	Expected Loading Amps	Derated Amps	% Derating	% Loading
TR-S	50	2510	1425 **	2475	1.39	57.5
TR-S	100	2510	1885 *	2398	4.47	78.6
TRN-2	100	2928	2231.6 **	2700	7.79	82.6
TRN-2	105	2928	2379.7 **	2652	9.43	89.7

* One RRC pump in 12 pulse mode

** Two RRC pumps in 12 pulse mode

Table 6.1

Generation Mode 105% Drive Speed AB-AB Channel Modes
TR-N2
TRANSFORMER HARMONIC DERATING FACTOR
EXAMPLE FROM
ANSI C57.110 - SECTION 5.3.1

KVA = 35000
KV = 6.9
Pec-r = 1.32

RATED AMPS = 2928.59

			CONST HARM MAG			CONST HARM PERCENT			
H	I_h(amps)	I_h (pu)	I_h^2	H^2	$I_h^2H^2$	I_h/I_1	F_h^2	$F_h^2H^2$	
1	2379.70	0.81258	0.66028	1.00	0.66028	1.00000	1.00000	1.00000	
5	24.00	0.00820	0.00007	25.00	0.00168	0.01009	0.00010	0.00254	
7	16.20	0.00553	0.00003	49.00	0.00150	0.00681	0.00005	0.00227	
11	98.40	0.03360	0.00113	121.00	0.13660	0.04135	0.00171	0.20689	
13	73.80	0.02520	0.00064	169.00	0.10732	0.03101	0.00096	0.16254	
17	5.10	0.00174	0.00000	289.00	0.00088	0.00214	0.00000	0.00133	
19	3.80	0.00130	0.00000	361.00	0.00061	0.00160	0.00000	0.00092	
23	26.20	0.00895	0.00008	529.00	0.04234	0.01101	0.00012	0.06412	
25	17.90	0.00611	0.00004	625.00	0.02335	0.00752	0.00006	0.03536	
TOTAL			0.66226		0.97455		1.00300	1.47597	= K-FACTOR

CONSTANT HARMONIC MAGNITUDES

Max Allowed Ifund = 2652.489 Amps
Max Fund KVA = 31700.3 KVA
% Derating = 9.427714

NOTES:
1. Pec-r is the rated eddy current heating effect as a percentage of conductive losses times 400% (value based on calculation)
2. As Pec-r increases, eddy current heating is more significant and greater derating is required.
3. Pec-r provided by manufacturer (0.32)

Table 6.2
Start-Up Mode 100% Drive Speed AB Channel Modes
TR-S
TRANSFORMER HARMONIC DERATING FACTOR
ANSI C57.110 - SECTION 5.3.1

KVA = 30000
KV = 6.9
Pec-r = 1.4

RATED AMPS = 2510.22

			CONST HARM MAG			CONST HARM PERCENT			
H	I_h(amps)	I_h (pu)	I_h^2	H^2	$I_h^2H^2$	I_h/I_1	F_h^2	$F_h^2H^2$	
1	1885.00	0.75093	0.56390	1.00	0.56390	1.00000	1.00000	1.00000	
5	14.20	0.00566	0.00003	25.00	0.00080	0.00753	0.00006	0.00142	
7	9.70	0.00386	0.00001	49.00	0.00073	0.00515	0.00003	0.00130	
11	57.90	0.02307	0.00053	121.00	0.06438	0.03072	0.00094	0.11416	
13	43.80	0.01745	0.00030	169.00	0.05145	0.02324	0.00054	0.09125	
17	3.00	0.00120	0.00000	289.00	0.00041	0.00159	0.00000	0.00073	
19	2.20	0.00088	0.00000	361.00	0.00028	0.00117	0.00000	0.00049	
23	15.40	0.00613	0.00004	529.00	0.01991	0.00817	0.00007	0.03531	
25	10.60	0.00422	0.00002	625.00	0.01114	0.00562	0.00003	0.01976	
TOTAL			0.56484		0.71300		1.00167	1.26442	= K-FACTOR

CONSTANT HARMONIC MAGNITUDES

Max Allowed Ifund = 2398.054 Amps
Max Fund KVA = 28659.5 KVA
% Derating = 4.468333 %

NOTES:
1. Pec-r is the rated eddy current heating effect as a percentage of conductive losses.
2. As Pec-r increases, eddy current heating is more significant and greater derating is required.
3. Pec-r Assumed not actual transformer number