TVA

Tennessee Valley Authority, Post Office Box 2000, Spring City, Tennessee 37381-2000

February 3, 2014

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555-0001

Watts Bar Nuclear Plant, Unit 2 — 10 CFR 50.4
NRC Docket No. 50-391

Subject: Watts Bar Nuclear Plant (WBN) Unit 2 – Diesel Generator Frequency – Response to NUREG 0847 Supplemental Safety Evaluation Report (SSER) 22, Open Item 32

Reference: 1. NUREG 0847 Supplemental Safety Evaluation Report 22, dated February 2011, Appendix HH, Watts Bar Unit 2 Action Items Table

This letter provides TVA's response to NRC's information request contained in SSER 22, Appendix HH, Item 32 (Reference 1).

Enclosure 1 provides a description of and the basis for the diesel generator (DG) steady state frequency and voltage range. The evaluation demonstrates that the frequency and voltage range selected has a negligible impact on equipment powered by the DGs.

Enclosure 2 provides a description of the proposed changes to the WBN Unit 2 Developmental Technical Specifications (TS) to modify the acceptance criteria for the DG steady state frequency range provided in applicable Surveillance Requirements (SR). The current SR 3.8.1.2 frequency is greater than or equal to (≥) 58.8 Hz and less than or equal to (≤) 61.2 Hz. The proposed change to SR 3.8.1.2 will result in a 60.0 Hz nominal frequency. The frequency will be changed from ≥ 58.8 Hz and ≤ 61.2 Hz to ≥ 59.8 Hz and ≤ 60.1 Hz for SRs 3.8.1.7, 3.8.1.11, 3.8.1.12, 3.8.1.15, 3.8.1.19, and 3.8.1.21. Associated TS Bases Section B 3.8.1 will also be revised to reflect the proposed changes. The TS and TS Bases revisions have been identified as Developmental Revision I.

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Attachment 1 to Enclosure 2 provides the original WBN Unit 2 TS pages marked-up to show the changes. Attachment 2 to Enclosure 2 provides the original WBN Unit 2 TS Bases pages marked-up to show the changes.

There is one new regulatory commitment associated with this submittal as detailed in Enclosure 3 of this letter. If you have any questions, please contact me at (423) 365-1260 or Gordon Arent at (423) 365-2004.

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 3rd day of February, 2014.

Respectfully,

R. A. Hruby, Jr.

Raymond A. Hruby, Jr.
General Manager, Technical Services
Watts Bar Unit 2

Enclosures:

1. Response to SSER Open Item 32
2. Technical Specification (TS) and Technical Specification Bases (TSB) Mark-Ups
3. List of Regulatory Commitments

cc (Enclosures):

U. S. Nuclear Regulatory Commission
Region II
Marquis One Tower
245 Peachtree Center Ave., NE Suite 1200
Atlanta, Georgia 30303-1257

NRC Resident Inspector Unit 2
Watts Bar Nuclear Plant
1260 Nuclear Plant Road
Spring City, Tennessee 37381

Enclosure 1
Response to Supplemental Safety Evaluation Report (SSER) 22, Open Item 32

NRC Information Request:

"TVA has added administrative limits to the plant operating procedures for both [EDG] voltage and speed range. These administrative limits are so tight that there would be negligible impact on the [EDG] loading due to off-normal frequency and voltage.

TVA should provide to the NRC staff the details of the administrative limits of EDG voltage and speed range, along with the basis for its conclusion that the impact is negligible. TVA should also describe how it accounts for the administrative limits in the TS surveillance requirements for EDG voltage and frequency."

Response:

This evaluation addresses Supplemental Safety Evaluation Report (SSER) 22, Open Item 32 and the subsequent and related Tennessee Valley Authority (TVA) proposed change to the Watts Bar Nuclear Plant (WBN) Unit 2 Developmental Technical Specifications (TS) to modify the acceptance criteria for the diesel generator (DG) steady state frequency range.

In March 2009, the initial WBN Unit 2 Developmental TS were submitted as Revision A, and established the WBN Unit 2 DG frequency range as greater than or equal to (≥) 58.8 Hz and less than or equal to (≤) 61.2 Hz (Reference 2.11). This submittal provides a new, more restrictive frequency range of ≥ 59.8 Hz to ≤ 60.1 Hz.

As delineated in paragraph 3.1 of Watts Bar System Description NPG-SDD-WBN2-82-4002, "Standby Diesel Generator System" (Reference 2.1), the DG frequency setpoint is 60 Hz with an acceptable as left limit of 60.00 to 60.10 Hz. In order to confirm that the existing DG governor system is capable of maintaining this limit, Calculation IDQ0000822011001 (Reference 2.2) was developed. This calculation evaluated the test data obtained from WBN DG testing per surveillance instructions 0-SI-82-3, 4, 5 and 6 since July 30, 1999 to the present. The test data frequency ranged from 60.0 Hz to 60.1 Hz. The calculation concluded that, there was no drift in the governor based on the subject test data, the existing DG governor system is capable of maintaining the DG frequency between the lower (59.8 Hz) and the upper (60.1 Hz) limit, as well as the more restrictive administrative limit of 60.0 to 60.1 Hz.

Calculation MDQ00299920110380 (Reference 2.3) evaluated the impact of DG frequency over the range of 59.8 Hz to 60.1 Hz, and voltage over the range of 6,800 V to 7,260 V. The calculation concluded that the equipment powered by the DGs and required for mitigating the effects of a Loss of Offsite Power (LOOP) or a Loss of Coolant Accident (LOCA) coincident with a LOOP (LOOP/LOCA) are capable of performing their intended safety function over the stated frequency and voltage ranges.

Calculation EDQ00099920080014 (Reference 2.4) evaluated the impact of the over-frequency on the DG load capability and concluded that the resulting loading is within the DG capacity.

Based on the above analyses, TVA proposes to conservatively 'narrow' the DG frequency range by increasing the current DG frequency lower limit of ≥ 58.8 Hz to

≥ 59.8 Hz, and decreasing the current upper limit from the existing ≤ 61.2 Hz value to ≤ 60.1 Hz in the WBN Unit 2 TS and TS Bases. The proposed WBN Unit 2 DG frequency steady-state operating range is summarized below in Table 1.

Table 1 - Technical Specification DG Steady-State Operating Range	
Parameter	**Range**
Frequency	≥ 59.8 Hz to ≤ 60.1 Hz
Voltage	6,800 V to 7,260 V

In addition, the proposed TS and TSB changes are submitted with this letter as Developmental TS and TS Bases, Revision I. The results of these analyses are provided in the Technical Evaluation provided below. This change will be implemented to the surveillance performed every 184 days, 18 month, and ten (10) year intervals when maintenance & test equipment (M&TE) is installed on the DG per the surveillance instructions.

TVA proposes to modify the Surveillance Requirement (SR) section (i.e., SR 3.8.1.7, 3.8.1.11, 3.8.1.12, 3.8.1.15, 3.8.1.19, and 3.8.1.21) of the technical specification bases to clarify that the revised lower (59.8 Hz) and revised upper (60.1 Hz) limit of the DG frequency applies only during the steady state condition of DG operation.

With respect to the monthly surveillance performed on the DG, TVA will revise this surveillance (i.e., SR 3.8.1.2) to confirm that the nominal frequency value of 60 Hz is achieved. During the monthly testing, the DG is not in accident mode and is, therefore, controlled by the operator rather than the governor's accident speed reference. The verification to nominal value provides assurance that the governor is functional.

The DG voltage limits as described in the technical specification are correct as validated by these analyses.

1.0 TECHNICAL EVALUATION

1.1 System Description

The onsite Class 1E Alternating Current (AC) Distribution System supplies electrical power to four power trains, shared between the two units, with each train powered by an independent Class 1E 6.9 kV shutdown board. Power trains 1A and 2A comprise load group A, and power trains 1B and 2B comprise load Group B. Two DGs associated with one load group can provide all safety related functions to mitigate a loss-of-coolant accident (LOCA) in one unit and safely shutdown the opposite unit. Each 6.9 kV shutdown board has two separate and independent offsite sources of power as well as a dedicated onsite DG source. Each A and B train Engineered Safety Features (ESF) system provides for the minimum safety functions necessary to shut down the plant and maintain it in a safe shutdown condition.

Each DG consists of two 16-cylinder engines directly connected to a 6.9 kV generator. The continuous rating of each DG is 4400 kilowatt (kW) at 0.8 power factor, 6.9 kV, 3-phase, and 60 Hz. Each DG also has an additional rating of 4840 kW for 2 hours out of 24 hours (Reference 2.1).

Ratings for the DGs satisfy the requirements of Regulatory Guide 1.9, "Selection, Design, Qualification, and Testing of Emergency Diesel-Generator Units Used as Class 1 E Onsite Electric Power Systems at Nuclear Power Plants." The continuous service rating of each DG is 4400 kW with 10% overload permissible for up to 2 hours in any 24 hour period (Reference 2.1).

The normal operating speed of the DGs is 900 rpm. The DGs use a tandem arrangement; that is, each DG consists of two diesel engines with a generator between them connected together to form a common shaft. The DGs are physically separated, electrically isolated from each other, and located above the water level of the probable maximum flood.

The DGs are equipped with Woodward Model 2301A electronic governors with a Woodward EGB-13P actuator and magnetic speed pickup on each engine. The manufacturer states that the steady state speed control will be within 0.25 percent of rated speed. The governor design includes circuits to provide high- and low-limit adjustments. These limits set the maximum and minimum speed that can be set by varying the speed-setting milliamp or voltage reference. The low limit can be set as high as rated speed, if desired, eliminating the ability of the process or controller speed setting to reduce speed. The setpoint of the electrical governor at WBN Unit 2 is set at a speed equivalent to 60 Hz (i.e., 59.95 Hz ± 0.05 Hz).

The WBN Unit 2 voltage and frequency regulators for the DG were evaluated to ensure they were capable of meeting the TS and SRs. The WBN Unit 2 DG voltage and speed regulators are independent of each other (i.e., the regulators are not volts (V) per hertz (Hz) regulators). In order to demonstrate this independence, historical test data of the current governors was evaluated utilizing a Pearson product-moment correlation coefficient (PPMCC). The evaluation was documented in calculation IDQ000082201 1001 (Reference 2.2).

It was also determined that the measured values for both voltage and frequency did not exhibit drift and were consistently within the respective setting band (reference 2.2). Operation outside both the frequency and voltage setting band would require both the speed controller and voltage regulator to operate erroneously.

Based on this independence and stability, the composite impact of frequency and voltage were evaluated independently for the Technical Specification band in calculation MDQ00299920110380 (Reference 2.3). The frequency range was analyzed over the full range (i.e., 59.8 Hz to 60.1 Hz) within the voltage setting range of (i.e., 6925 V to 7000 V). Likewise, the voltage (i.e., 6800 V to 7260 V) was analyzed over the full frequency range within its setting range (i.e., 59.90 Hz to 60.00 Hz).

The DG will be set within a speed band which is equivalent to a frequency band of 59.95 Hz ± 0.05 Hz. Likewise the DG will be set within a voltage band of 6900 V, +50 V and -25 V. In the event that the speed (frequency) or voltage is found outside of their setting band, the 'as-found' values will be reset within the setting band, and the 'as-found' values will be entered into the WBN corrective action program (CAP) for evaluation of performance.

The WBN Unit 2 DG electrical governor frequency setting is described in further detail in document, NPG-SDD-WBN2-82-4002, "NPG System Description Document - Standby Diesel Generator System" (Reference 2.2). The DG governor setting methodology for speed (frequency) and voltage is consistent with the instrument calibration methodology used in Technical Specification Task Force (TSTF) Standards TS Change Traveler, TSTF - 493, Revision 4, "Clarify Application of Setpoint Methodology for LSSS Functions" (Reference 2.12).

The NSSS vendor, Westinghouse performed an evaluation of the Emergency Core Cooling System (ECCS) (Reference 2.6). Westinghouse utilized 6,600 V for the ECCS motor terminal voltage and a nominal frequency of 60.0 Hz for the analysis. It was also determined that a ± 0.3% motor speed variation would be acceptable since it equates to an effective frequency variation of ± 0.2 Hz (i.e., ((0.2 Hz / 60 Hz) x 100% = 0.3%), if the ECCS motors were at the rated voltage of 6,600 V. The composite effect of the voltage and frequency ensures that the ECCS pump speeds do not deviate more than 0.3% of rated values at rated horse power.

Tests confirming that the frequency is maintained in the specified limits are performed using the Diesel Generator Data Acquisition System (DG-DAQ). The DG-DAQ system is a portable data acquisition system developed by TVA for use as maintenance and test equipment (M&TE) for the DG at TVA nuclear sites in order to satisfy plant technical specification and testing requirements. The system is specifically designed for DG load sequence, fast start, and load rejection surveillance testing at all TVA nuclear sites. The system is also capable of evaluating DG power system performance during startup, loading, and steady-state operation. The following are significant attributes of the DC-DAQ:

- Does not use transducers which can introduce measurement and integration errors. The DG-DAQ connects directly to the DG potential transformer and current transformer metering cutouts and directly (over) samples the voltage and current waveforms. The desired scan rate is 2,000 scans per second.

- Highly-accurate software algorithms are used to calculate power system parameters (true rms, frequency, power components) from the voltage and current waveforms.

- Superior accuracy: true rms voltage and current measured within 0.13% and frequency within 0.03% at the theoretical limit of one cycle resolution.

This test equipment verifies that the governor controls the DG frequency within the steady-state operational band of ≥ 59.8 Hz to ≤ 60.1 Hz.

1.2 Evaluation

1.2.1 Introduction

Evaluations were conducted to determine the effects of the DG frequency variation between 59.8 Hz to 60.1 Hz on plant equipment fed by these generators following a Loss of Offsite Power (LOOP) or a Loss of Coolant Accident (LOCA) coincident with a LOOP.

The changes in frequency from the nominal rating of 60 Hz assumed by Westinghouse (Reference 2.6) has the direct effect of changing motor speeds for the motors fed from the generators following a LOOP or a LOCA/LOOP. The changes in motor speeds affect the following attributes:

1. Pump flow, Net Positive Suction Head (NPSH) availability and horsepower requirements,
2. Fan flow and horsepower requirements,
3. Motor operated valves opening/closing speed and horsepower requirements,
4. Air compressor flow and horsepower requirements, and
5. Chiller horsepower requirements

The changes in these parameters were evaluated to demonstrate that the subject equipment would continue to meet their safety related functions within the analyzed bounds documented in design documents. In addition, the increased horsepower associated with increased frequency was evaluated to ensure that the horsepower increases do not result in exceeding the sustained load ratings for the DGs and the decreased flowrate with decreased frequency was evaluated to ensure pump parameters are adequate. Battery chargers and power transformers do not have motors, but frequency changes were examined to determine if the chargers and transformers would provide acceptable output parameters to continue to meet the specifications and requirements of the downstream components.

Note that there are several large and small pumps identified in the DG loading list. Only major pumps in safety significant systems were individually evaluated and the results are summarized in Table 1. The Table 1 results conclude that the speed, load, flow, and NPSH are only slightly impacted (i.e., ± 0.3% to ± 1.0%).

The following equations were utilized to determine the impacts:

- $f = Np/120$, thus synchronous speed (N) is directly proportional to frequency (f) since the number of poles (p) is constant.
- Horsepower (HP)varies directly with the cube of the speed (i.e. $HP_1/HP_2 = S_1^3/S_2^3$);

- Flow (Q) varies directly with speed (i.e. $S_1/S_2 = Q_1/Q_2$);
- Head (H) losses vary directly with square of the speed (i.e. $S_1^2/S_2^2 = H_1/H_2$); and
- Valve stroke times vary inversely with speed since they are gear driven.

Table 2 provides a summary of the effective frequency as related to the various design parameters associated with the DGs and subsequently powered component categories.

Table 2 – Effective Frequency as Related to Various Parameters

Parameter	Lower Speed (- 0.3%) Effects	Higher Speed (+ 0.3%) Effects
Motor Speed (S)	Slower: $S_2 = (59.8/60.0) * S_1$, thus $S_2 = 0.997 * S_1$	Faster: $S_2 = (60.2/60.0) * S_1$, thus $S_2 = 1.003 * S_1$
Motor Brake Horsepower (BHP)	Decreased: $BHP_2 = (59.8/60.0)^3 * BHP_1$, thus $BHP_2 = 0.990 * BHP_1$	Increased: $BHP_2 = (60.2/60.0)^3 * BHP_1$, thus $BHP_2 = 1.010 * BHP_1$
Pump Flow (Q)	Decreased: $Q_2 = (59.8/60.0) * Q_1$, thus $Q_2 = 0.997 * Q_1$	More: $O_2 = (60.2/60.0) * Q_1$, thus $O_2 = 1.003 * Q_1$
Pump NPSH available (NPSHa)	Increased margin by decreasing flow loss component of NPSH: $\Delta P_2 =(59.8/60.0)^2 * \Delta P_1$, thus $\Delta P_2 = 0.993 * \Delta P_1$	Decreased margin by increasing flow loss component of NPSH: $\Delta P_2 = (60.2/60.0)^2 * \Delta P_1$, thus $\Delta P_2 = 1.007 * \Delta P_1$
Fan Flow (Q)	Less: $Q_2 = (59.8/60.0) * Q_1$, thus $Q_2 = 0.997 * Q_1$	More: $Q_2 = (60.2/60.0) * Q_1$, thus $Q_2 = 1.003 * Q_1$
Valve Opening Time (T)	Increased: 1.008 (i.e., +0.8%)	Decreased: 0.994 (i.e., -0.6%)
Valve Closing Time (T)	Increased: 1.008 (i.e., +0.8%)	Decreased: 0.994 (i.e., -0.6%)
DG Loading	Decreased: 0.990 (i.e., -1.0%)	Increased: 1.010 (i.e., +1.0%)

1.2.2 Effects on Motors

Motors are designed to operate with a voltage of ± 10% of rated voltage and frequency variation of ± 5% of rated frequency (Reference 2.3). The impact to starting torque on motors is proportional to the square of the voltage and inversely proportional to the square of the frequency. Starting capability of safety related motors are analyzed for the degraded voltage set point of 6,555 V (95%) when supplied by offsite power. When the diesel generator is supplying the shutdown equipment the voltage is maintained above 6,800 Volts (98%). The impact on starting torque at 60.1 Hz (0.1 Hz effective frequency change is reserved for voltage impact) is well bounded by the impact on starting voltage which has already been analyzed on offsite power.

The effect on motor operating temperature is proportional to the square of the horsepower to rated horsepower ratio as:

$$\Delta T_{insul} = (P/P_{sf})^2 * TR_{sf}$$

Where: P = motor power
P_{sf} = motor power at service factor
TR_{sf} = temperature rise of the insulation at service factor

For pumps operating at 59.8 Hz, this relationship equates to:

$$(0.990\ P/P_{SF})^2 * TR_{SF} = 0.980 * TR_{SF}$$

For pumps operating at 60.2 Hz, this relationship equates to:

$$(1.010\ P/P_{SF})^2 * TR_{SF} = 1.020 * TR_{SF}$$

A 2.0% increase or decrease in heat rise would have insignificant impact on motor life. In the case of continuously operated 480 V EQ motors the 40 year qualified life of the motor is based on an insulation temperature rise of 105 °C. Actual tested rise is ≤ 75 °C. Therefore, there is more than sufficient margin in the windings.

1.2.3 Pump Flow

Pump speed is directly proportional to flow (Reference 2.3). Therefore, a 0.3% speed increase will result in slightly higher flows and 0.3% decrease will result in slightly lower flows. The flow is considered acceptable if they are equal to or greater than those used in the safety analysis. For the Steam Generator Tube Rupture Margin To Overfill Analysis, the higher pump flow rates associated with a + 0.3% motor speed increase was analyzed for the Centrifugal Charging Pumps (CCP) and Safety Injection (SI) Pumps.

For the long term mitigation of a LOCA/LOOP, the DGs supply the following major pumps:

- Auxiliary Feedwater (AFW) Pump
- Containment Spray (CSS) Pump
- Residual Heat Removal (RHR) Pump
- Safety Injection (SI) Pump
- Centrifugal Charging (CC) Pump
- Emergency Raw Cooling Water (ERCW) Pump
- Component Cooling Water System (CCS) Pump

The DGs also supply the following minor pumps:

- Station Fire Pump – 200 HP
- Control Room Chilled Water Circulation Pump – 15 HP
- Shutdown Board Room (SDBR) Chilled Water Circulation Pump – 25 HP
- Electric Board Room Chilled Water Circulation Pump – 20 HP
- DG Day Tank Fuel Oil Transfer Pump – 1 HP
- Boric Acid Transfer Pump – 15 HP

- Thermal Barrier System Booster Pump – 10 HP
- AFW Pump Lube Oil Pump – 0.25 HP
- Spent Fuel Pool (SFP) Pump – 100 HP
- ERCW Screen Wash Pump - 40 HP

Only major pumps in safety significant systems were evaluated in detail, because, as summarized in Table 3, the speed, load, flow, and NPSH are only slightly impacted (i.e., 0.3%).

Pump flow will increase as follows:

$Q_2 = (60.2/60.0) * Q_1$, thus $Q_2 = 1.003 * Q_1$

The flow at higher frequency (60.2 Hz) will be 0.3% higher. The impact on pump flow is defined in Table 3. The impact involves a negligible increase and does not have any impact on design safety function of the pumps listed above.

Pump flow will increase as follows:

$Q_2 = 1.003 * Q_1$

Pump flow will decrease as follows:

$Q_2 = 0.997 * Q_1$

For example, the 3 gpm diesel generator lube oil circulation pump flow increase/decrease will be 0.009 gpm and the 11,800 gpm Emergency Raw Cooling Water Pump flow increase/decrease will be 35.4 gpm. This is a negligible increase/decrease and does not have an impact on the design safety function of the pumps listed above.

Table 3 – Impact on Pump Parameters			
Pump	**Rated Flow, gpm**	**Flow at -0.3%, gpm**	**Flow at +0.3%, gpm**
Auxiliary Feed Water	450	***449	***451
Containment Spray	4,550	4,536	4,564
RHR	5,000	4,985	5,015
Safety Injection	675	673	677
Centrifugal Charging (Normal)	150	****150	****150
Centrifugal Charging (LOCA)	550	548	552
ERCW	11,800	11,765	11,835
Component Cooling - Trains A & B	6,000	5,982	6,018
Component Cooling - 2A-A**	9,500	9,472	9,529

** Component Cooling System (CCS) pump 2A-A has a flow range of 6,000 gpm to 9,500 gpm (Reference 2.3) and serves Unit 2 only components. All other CCS pumps have a design flow of 6,000 gpm.
*** These flow variances are insignificant with respect to NSSS flow transients and do not require further evaluation.
**** Calculated flow is insignificantly different than the design flow such that flow appears to be unchanged.

The NSSS vendor, Westinghouse, has evaluated the impact of a ± 0.3% speed variation (i.e., 60 ± 0.2 Hz effective) on WBN Unit 2 pump flows and determined that previous analyses remain valid or do not significantly impact previous analyses (Reference 2.6). To support Westinghouse's DG frequency range evaluation, Flowserve, the ECCS pump vendor provided input as to the expected performance of the Centrifugal Charging pumps and Intermediate Head Safety Injection pumps for continuous operation up to 30 days. Flowserve concluded that both pumps are expected to undergo minor cavitation damage, but would remain operational with gradual decline in pump/power performance (Reference 2.3).

For 480 V motors, the speed reduction will be 0.3% to 0.5% due to greater voltage drop and higher rated motor slip (Reference 2.3, Appendices 3 & 4). The speed reductions are small and intermittent in nature, and therefore would not be of concern with respect to motor operation and subsequent pump flow.

The Westinghouse evaluation of the effect of the DG frequency range ≥ 59.8 Hz and ≤ 60.2 Hz (assuming rated terminal voltage, 6600 V, or ± 3% speed change) on pump flow rate determined that the previous analyses for the following conditions remain valid or were not significantly affected.

- Large Break LOCA
- Post LOCA Long Term Core Cooling
- Small Break LOCA
- Post LOCA Subcriticality
- Steam Generator Tube Rupture
- Transient Analysis (non-LOCA events)
- Steam Line Break Mass and Energy Release
- LOCA Mass and Energy Release

1.2.4 Pump Net Positive Suction Head (NPSH)

Table 4 provides a summary of the Net Positive Suction Head (NPSH) values for the selected pumps. The increased speed during operation at 60.1 Hz will result in increased flows which in turn increase suction side losses and reduces available NPSH (NPSHa). The decreased speed will result in decreased flows which in turn decreases suction side losses and increases available NPSH.

The margin is changed by ± 0.7 % as suction losses increase/decrease by 0.7%.

For increased speed (+ 0.3%): $\Delta P_2 = 1.007 * \Delta P_1$

For decreased speed (- 0.3%): $\Delta P_2 = 0.993 * \Delta P_1$

The decreased speed during operation at 59.8 Hz would result in reduced flows which in turn reduce suction side losses and increase NPSHa. As shown in Table 4, the margin between NPSHa and the required NPSH (NPSHr) would increase by approximately 0.7% at a frequency of 59.8 Hz as compared to during operation at a frequency of 60.0 Hz. A 0.7% increase in NPSH margin (i.e., NPSHa – NPSHr) adds to the margin and does not require additional evaluation. Table 4 provides a comparison of the NPSH values for the major pumps.

Table 4 - NPSH Evaluation

Pump	NPSHr, ft	Increased Margin NPSHr (60.2 Hz, +0.3%), ft	Decreased Margin NPSHr (59.8 Hz, -0.3%), ft	NPSHa, ft
Auxiliary Feed Water	25.0	24.8	25.2	25.86
Containment Spray	13.2	13.1	13.3	18.73
RHR	16.5	16.4	16.5	25.5
Safety Injection	25.0	24.8	25.2	54.1
Centrifugal Charging	28.0	27.8	28.2	55.4
ERCW (submergence requirement)	6.03	5.99	6.07	12.07
Component Cooling - A Train	10.57	10.5	10.64	20.06
Component Cooling – B Train	17.38	17.26	17.50	24.88
Component Cooling - Pump 2A-A (8,444 gpm)***	29.25	29.05	29.45	29.57

*** The NPSH information provided here for CCS Pump 2A-A is for tornadic conditions. At any other time, NPSHa increases by an additional 8.904 feet.

As shown in Table 4, the NPSHa is greater than the NPSHr during operation in the range of 59.8 Hz to 60.2 Hz. Therefore, operation in a frequency range ≥ 59.8 Hz and ≤ 60.2 Hz would have no significant effect on pump NPSH.

1.2.5 Motor Horsepower

As shown in Table 2, the flow during pump operation at 59.8 Hz would be approximately 1% lower than at a frequency of 60.0 Hz. In addition, Tables 2 and 5 show that operation of pumps at 59.8 Hz results in reduced brake horsepower (BHP) for each pump. Therefore, operation in a frequency range ≥ 59.8 Hz and ≤ 60.1 Hz would have no significant effect on motor BHP.

In addition, also defined in Table 2, the brake horsepower at higher frequency will be 0.6% higher. Table 5 provides the BHP for the major pumps that would be supplied power by the DGs in the event of a LOCA/LOOP (Reference 2.5). The general acceptance criterion for horsepower is that the brake horsepower shall not exceed the motor nameplate rating times the motor service factor (Reference 2.5). Only major pumps in safety significant systems were evaluated, because, as shown in Table 2, the speed, load, flow, and NPSH are only impacted slightly (i.e., 0.2% to 0.6%). The Spent Fuel Pool pump motor and the high pressure fire protection pump motors operate at a horsepower that is less than their nameplate rating at a frequency of 60.1 Hz. The other pumps are low power and the increase in horsepower is negligible. In addition, the increase in horsepower due to the increase in frequency is less than the nameplate rating times the service factor.

Pump motor brake horsepower at higher speeds (+ 0.3%) will be slightly higher as follows:

$$BHP_2 = 1.010 * BHP_1$$

Pump motor brake horsepower at lower speeds (- 0.3%) will be slightly lower as follows:

$$BHP_2 = 0.990 * BHP_1$$

The brake horsepower with a speed variation of ± 0.3% will vary by 1.0%. Table 5 provides a summary of the major pump brake horsepower.

Table 5 - Brake Horsepower

Pump	Normal / Accident Brake Horsepower (HP)			Design
	Rated (@ 60.0 Hz Effective)	-0.3% (@ 59.8 Hz Effective)	+0.3% (@ 60.2 Hz Effective)	Name Plate (HP)
Auxiliary Feed Water **	601.5	595.6	605.1	600
Containment Spray	595.1	589.1	598.69	700
RHR	440.0	435.6	442.64	400
Safety Injection	453.4	448.9	456.12	400
Centrifugal Charging	695.0	688.1	699.17	600
ERCW **	805	797	809.83	800
Component Cooling - Trains A & B and 2A-A	360 ***(370)	356 ***(366)	***362.16	350

** See Sections 1.2.5.1 and 1.2.5.2 for additional evaluation regarding temperature increase for these pump motors.
*** CCS Pump 2A-A is permitted to operate at flow rates resulting in excess of 360 BHP (but less than 378 BHP) for the operating range identified in Table 4 (Reference 2.3).

All pumps have a slight increase/decrease in horsepower requirement; however, technical justification was provided for their acceptance (Reference 2.3):

1. The RHR, SI, CCS, and ERCW pump motors have a service factor of 1.15 and meet the standard acceptance criteria.

2. The CSS and ERCW screen wash pump motors do not exceed the nameplate rating and therefore, are acceptable
3. The CCP motors were evaluated by Westinghouse to be acceptable for continuous operation up to 720 horsepower (Reference 2.6). WBN Unit 2 centrifugal charging pumps have 0.6% higher brake horsepower than WBN Unit 1 (which is about 5 HP). The horsepower calculation was performed at conservative flows and this slightly higher/lower horsepower does not impact pump performance at an effective ± 0.3% speed change.
4. The AFW pump motors and the ERCW pump motors were specifically evaluated to determine the temperature rise as a result of the higher frequency. Refer to Sections 1.2.5.1 and 1.2.5.2. The temperature rise was small and the winding temperatures were well below the insulation temperature limit.

1.2.5.1 Auxiliary Feedwater Pump Motor Horsepower

The brake horsepower for the Auxiliary Feedwater Pump Motors with a speed increase of 0.3% would be 607.5 HP. The motors for these pumps have Class F insulation with a maximum allowable temperature rise of 105 °C. At 600 HP, the temperature rise for the motor is 57.4 °C. Therefore, at 607.5 HP, the temperature rise would be:

$$\Delta T_{INSULATION} = (P/P_{SF})^2 * (TR_{SF})$$

Where: P = motor power
P_{SF} = motor power at service factor
TR_{SF} – temperature rise of the insulation at service factor

$$(P/P_{SF})^2 * (TR_{SF}) = (607.5/600)^2 * (57.4\ ^\circ C) = 58.8\ ^\circ C$$

Thus, there is a negligible increase in temperature. Since the maximum allowable rise is 105 °C, less than 2 °C temperature rise is judged to be negligible.

1.2.5.2 ERCW Pump Motor Horsepower

For the ERCW Pump motors, the brake horsepower at a speed increase of 0.3% would be 813.1 HP. The motors for these pumps have Class F insulation with a maximum allowable temperature rise of 105 °C. At 800 HP, the temperature rise for the motor is 51 °C. Therefore, at 813.1 HP, the temperature rise would be:

$$(P/P_{SF})^2 * (TR_{SF}) = (813.1/800)^2 * (51\ ^\circ C) = 52.7\ ^\circ C$$

Thus, there is a negligible increase in temperature. Since the maximum allowable rise is 105 °C, less than 2 °C temperature rise is judged to be negligible.

1.2.6 Positive Displacement Pumps

The Fuel Oil Transfer Pump (FOTP), a positive displacement pump transfers fuel oil from the fuel oil storage tank in the yard to the DG seven-day fuel oil tanks. The FOTP serves to replenish the volume of the seven-day tanks during DG operation. Slightly higher/lower flow rates results in the completion of the fuel oil transfer process in slightly faster/slower time durations. The slightly higher/lower horsepower requirement (i.e., ±1.0%) and associated resultant slightly higher/lower flow rates has no impact of the safe operation of the FOTP, or the operation of the DGs.

1.2.7 Fan Flow

For the long term mitigation of a LOCA/LOOP, the DGs supply the following fans and air handling units:

- Containment Air Return Fan
- Electrical Board Room Air Handing Unit (AHU)
- Penetration Room Elevation 713' Cooler Fan
- Pipe Chase Cooler Fan
- 480V Board Room Pressurizing Air Supply Fan
- 480V Board Room Air Conditioning (A/C) AHU
- Control Room AHU
- 125V Vital Battery Room II Exhaust Fan
- Control Bldg Emergency Pressurizing Air Supply Fan
- Control Bldg Emergency Air Clean-up Fan
- Penetration Room EL 692 Cooler Fan
- Containment Spray Pump Room Cooler Fan
- Battery Room El 692' Exhaust Fan
- 5^{th} Vital Battery Room Exhaust Fan
- Emergency Gas Treatment System Fan
- SFP Pump & TB Booster Pump Space Cooler Fan
- CCS & AFW Pumps Space Cooler Fan
- 125V Vital Battery Room Exhaust Fan
- Safety Injection Pump Room Cooler Fan
- Penetration Room El 737' Cooler Fan
- RHR Pump Room Cooler Fan
- 480V Transformer Room Exhaust Fan
- Diesel Generator Room Exhaust Fan
- Diesel Room Panel Vent Fan
- DG 480V Electrical Board Room Exhaust Fan
- DG Muffler Room Exhaust Fan

Fan speed is directly proportional to flow. Therefore, increased speed will result in increased air flow and similarly for decreased fan speeds. From Table 2, it can be seen that fan flow will be ± 0.3% higher/lower. TVA General Engineering Specification (G-Spec) G-37 (Reference 2.7) stipulates that total system airflow at the system fan and/or inlet shall not be less than 90 % of fan design rated flow for existing system and 95 % of fan design rated flow for new systems for other than air-cleaning units. The specification continues that the maximum system flow shall not exceed 110% of the system's fan rated flow. Thus, for a 0.3% flow increase, the fan flows are within G-Spec tolerances.

Therefore, all of the fans affected by diesel generator frequency variation are acceptable from a flow standpoint.

1.2.8 Valve Operating Times

The motor operated valves (MOV) identified in TVA calculation WBN-EEB-MS-TI03-0012, "WBN Diesel Generator Loading Analysis" were evaluated for frequency and voltage related to DG loading (Reference 2.3).

Motor torque and stroke time are two important parameters associated with MOV performance. The DG frequency potentially impacts stroke time and DG voltage affects the motor torque. Valve stroke time is inversely proportional to motor speed. Therefore, slower motor speed resulting from operation at 59.8 Hz will result in longer valve stroke times. From Appendix 1 of Reference 2.3, the stroke time will be approximately 0.8% longer as a result of the change in the frequency and voltage. These changes are negligible, and will not prevent the motor operated valve from meeting its stroke time requirements. Longer stroke time is not a concern because sufficient margin exists between the calculated stroke times and stroke times used in the safety analysis such that the assumed stroke times will not be exceeded by the longer stroke time.

Therefore, longer motor operated valve stroke times due to operation in the frequency range of 59.8 to 60.0 Hz are not a concern. The safety related MOVs were evaluated and shown to perform acceptably considering a voltage below 6,600 (Reference 2.3). The minimum allowable DG voltage is 6,800 (Reference 2.3). More than adequate torque will be available to provide acceptable valve performance. Faster motor speed resulting from operation at 60.1 Hz will result in shorter valve stroke time. Shorter stroke time is not a concern because all pertinent stroke times used in the WBN Unit 2 safety analysis are the maximum stroke times. In addition, there would not be a concern for water hammer with expected decrease in stroke time that results from a frequency of 60.1 Hz. Therefore, there are no concerns with MOV operation due to the variation in DG frequency and voltage.

1.2.9 Air Compressor and Chiller Flows

For the long term mitigation of a LOCA/LOOP, the DGs supply the following compressors:

- Control Room A/C Compressor
- 480V Board Room A/C Compressor
- Shutdown BD Room Chiller Package Compressor
- Electrical Board Room A/C Compressor
- Aux Control Air Compressor

Air compressors and chillers are intermittently loaded equipment which store a commodity between selected high and low parameter setpoints within a fixed closed pressure boundary volume.

For air compressors, the compressor loads on to charge a header up to the high pressure setpoint and then unloads until header pressure drops below a setpoint. For chillers, the chiller compressor loads on and off to maintain the refrigerant fluid temperature within the recommended temperature ranges. Room temperature maintained by the A/C compressors and air compressor pressure are not impacted by the DG frequency change. Load times are directly proportional to the increase/decrease in rotational speed. A ± 0.3% change in load times for intermittently operated equipment has negligible impact on the equipment and service to the plant.

1.2.10 Power Transformers

The proposed frequency range is very small (i.e., 59.8 Hz - 60.1 Hz) and is within the acceptable and normal operating range for electrical equipment, including power transformers. Accordingly, there is no detrimental effect on power transformers and additional evaluation is not required.

1.2.11 Battery Chargers

For the long term mitigation of a LOCA/LOOP, the DGs supply the following safety related battery chargers:

- 125V Vital Battery Chargers

According to battery charger vendor manuals, as long as line frequencies are within ± 5% (3 Hz) of the rated frequency (i.e., 60 Hz), the charger will maintain steady state output within ± 0.5% of the desired voltage. The frequency range considered is 0.3%, therefore, the output from the battery chargers would only vary by 0.03%. This variation is considered to be negligible and there is no impact.

1.2.12 Hydrogen Igniters

The concern with the hydrogen igniters is that their operating temperature may be affected by changes in voltage and/or frequency, and subsequently their ability to control hydrogen following a LOCA. The hydrogen igniters are supplied by a regulated transformer which maintains a ± 1% regulation for a voltage range of ± 10% and frequency range of ± 5% (Reference 2.3). Therefore, there is no impact to the hydrogen igniters due to minor voltage and/or frequency variations.

1.2.13 Other Motors

The DGs supply other motors such as the Emergency Raw Cooling Water (ERCW) strainer and the traveling screens. These are small, intermittently operated motors, respectively. Therefore, the effect of small frequency variation is negligible and does not adversely affect these motors.

1.2.14 DG Loading

As described in Section 1.1, each DG has a continuous load rating of 4400 kW (i.e., 100% load) and a two-hour rating of 4840 kW (i.e., 110% load). Table 2 shows that DG load would decrease by approximately 10% during operation at 59.8 Hz as compared to operation at 60.0 Hz, and would increase by approximately 10% during operation at 60.2 Hz. The load reduction of approximately 10% during operation at 59.8 Hz results in an increase of margin to the DG load ratings while the load increase of approximately 10% during operation at 60.2 Hz results in a reduction of margin to the DG load ratings.

DG frequencies above 60 Hz directly increase motor speed and frequencies below 60 Hz directly decrease motor speed. Horsepower requirements for a motor increase/decrease by the cube of the speed change. Therefore; increased speed will result in increased horsepower demands and decreased speed will result in decreased horsepower demands on the diesel which feed the subject loads.

As stated above, the power consumption associated with electric motors increases/decreases by the cube of the speed change. Not all loads are affected by frequency increase (e.g. battery chargers and transformers); however, it is conservative to assume that they are affected. Therefore, if all of the total loads in Reference 2.1 are multiplied by 1.010, the total loading is still under the DG load rating.

The cumulative impact of the DG upper voltage limit of 7,260 V and frequency of 60.2 Hz has been evaluated for DG loading under the LOOP/LOCA scenario (Section 1.2.1) for DG 1A-A which is the heaviest loaded DG. Table 6 summarizes that DG 1A-A total loading.

Table 6 – DG 1A-A Maximum Steady State Running Load

Parameter	DG 1 A-A Load (2 hours - End)	Continuous Rating	Minimum Margin (%)
kW	4116	4400	6.4
kVA	4762	5500	13.4

Thus with conservative loading, it is seen that for a LOCA/LOOP scenario, the DG loading is within its continuous rating, have sufficient loading margin and therefore not analyzed any further.

1.2.15 DG Fuel Oil Consumption

In determining the required volume of fuel oil for seven days of operation, TVA assumed that the DGs operate at the two-hour overload rating of 4840 kW (i.e., 110% load) for the first two hours of the seven-day period. For the remaining 166 hours of the seven-day period, the DGs are assumed to operate continuously at 4400 kW (i.e., 100% load) (Reference 2.13, Sheet 18). As discussed in Section 1.2.14, the loading on each of the DGs while operating in the frequency range ≥ 59.8 Hz and ≤ 60.2 Hz remains below the two-hour and continuous ratings.

The DG fuel oil consumption calculation is performed at the DG continuous rating of 4,400 kW. The DG loading while operating at ≤ 60.2 Hz remains below the continuous rating of 4400 kW. Therefore, there is no impact to the calculated DG fuel oil consumption rate.

1.3 Summary

TVA evaluated frequency and voltage variation in the ranges of 59.8 to 60.1 Hz and 6,800 V to 7,260 V, respectively for WBN Unit 2 equipment fed by the DGs following a LOOP or LOCA/LOOP (Reference 2.3). The aspects examined were the effects of frequency and voltage increase/decrease on pumps, fans, motor-operated valves, compressors, power transformers, battery chargers, and hydrogen igniters. In addition, the effects of the proposed steady state DG frequency change on the DG steady state loading, and the DG fuel oil consumption rates were also evaluated. It was confirmed that the WBN Unit 2 Diesel Generator loading will not exceed the ratings or fuel oil consumption rates.

1.4 Conclusion

The WBN Unit 2 equipment required to mitigate the effects of a LOOP or LOCA/LOOP and which are fed by the DGs is capable of performing their intended functions for the frequency and voltage ranges examined. The variation in horsepower demand due to a frequency or voltage increase or decrease will not subject the DGs to operate above their load ratings in association with mitigation of a LOOP or LOCA/LOOP. This evaluation establishes an effective frequency and voltage range for WBN Unit 2 only.

2.0 References

2.1 TVA, NPG System Description Document, NPG-SDD-WBN2-82-4002, Revision 0002, "Standby Diesel Generator System"

2.2 TVA, Calculation IDQ0000822011001, Revision 0000, "WBN Diesel Generator Electrical Governor Setpoint Verification"

2.3 TVA, Calculation MDQ00299920110380, Revision 0004, "Evaluation of the Impact of Diesel Generator (DG) Frequency and Voltage Limits"

2.4 TVA, Calculation EDQ 00099920080014, Revision 0014, "Diesel Generator Loading Analysis"

2.5 TVA, Calculation EPM-GDU-041593, Revision 0023, "Brake Horsepower Analysis for Safety-Related Components"

2.6 Westinghouse Electric Company, 25402-011-G26-GAKS-09514, WBT-D-4290: WBS 2, "17 Watts Bar Unit 2 Final System Analysis DG Frequency Variation"

2.7 TVA, General Engineering Specification G-37, "Testing and Balancing of HVAC Systems During Installation, Modification, and Maintenance"

2.8 McGraw-Hill Book Company, "Pump Handbook," 4th Edition, 2008

2.9 TVA, Design Guide DG-E2.4.1, Revision 1, "Design Criteria and Procedures – Auxiliary Power System"

2.10 TVA Standard Specification, SS-E9.2.01, Revision 7, "Alternating-Current Induction Motors"

2.11 TVA, letter to the NRC, "Watts Bar Nuclear Plant (WBN) Unit 2 - Operating License Application Update Application," dated March 4, 2009

2.12 Technical Specification Task Force (TSTF) Standards TS Change Traveler, TSTF - 493, Revision 4, "Clarify Application of Setpoint Methodology for LSSS Functions," dated July 2009

2.13 EPM, Inc., Calculation EPMAAP081090, Revision 5, "Diesel Generator Fuel Oil 7 Day Tank Capacity and Level Setpoint Calculation"

Enclosure 2

Response to Supplemental Safety Evaluation Report (SSER) 22, Open Item 32

ATTACHMENT 1

Proposed TS Changes (Mark-Ups) for WBN Unit 2

3.8 ELECTRICAL POWER SYSTEMS

3.8.1 AC Sources - Operating

LCO 3.8.1 The following AC electrical sources shall be OPERABLE:

a. Two qualified circuits between the offsite transmission network and the onsite Class 1E AC Electrical Power Distribution System; and

b. Four diesel generators (DGs) capable of supplying the onsite Class 1E AC Electrical Power Distribution System.

APPLICABILITY: MODES 1, 2, 3, and 4.

ACTIONS

---NOTE---
LCO 3.0.4.b is not applicable to DGs.

CONDITION	REQUIRED ACTION		COMPLETION TIME
A. One offsite circuit inoperable.	A.1	Perform SR 3.8.1.1 for OPERABLE offsite circuit.	1 hour <u>AND</u> Once per 8 hours thereafter
	<u>AND</u>		
	A.2	Declare required feature(s) with no offsite power available inoperable when its redundant required feature(s) is inoperable.	24 hours from discovery of no offsite power to one train concurrent with inoperability of redundant required feature(s)
	<u>AND</u>		
			(continued)

ACTIONS

CONDITION	REQUIRED ACTION		COMPLETION TIME
A. (continued)	A.3	Restore offsite circuit to OPERABLE status.	72 hours <u>AND</u> 6 days from discovery of failure to meet LCO
B. One or more DG(s) in Train A inoperable. <u>OR</u> One or more DG(s) in Train B inoperable.	B.1	Perform SR 3.8.1.1 for the offsite circuits.	1 hour <u>AND</u> Once per 8 hours thereafter
	<u>AND</u>		
	B.2	Declare required feature(s) supported by the inoperable DG(s) inoperable when its required redundant feature(s) is inoperable	4 hours from discovery of Condition B concurrent with inoperability of redundant required feature(s)
	<u>AND</u>		
	B.3.1	Determine OPERABLE DG(s) is not inoperable due to common cause failure.	24 hours
	<u>OR</u>		
	B.3.2	Perform SR 3.8.1.2 for OPERABLE DG(s).	24 hours
	<u>AND</u>		
			(continued)

ACTIONS

CONDITION	REQUIRED ACTION		COMPLETION TIME
B. (continued)	B.4	Restore required DG(s) to OPERABLE status.	72 hours AND 6 days from discovery of failure to meet LCO
C. Two offsite circuits inoperable.	C.1	Declare required feature(s) inoperable when its redundant required feature(s) is inoperable.	12 hours from discovery of Condition C concurrent with inoperability of redundant required features
	AND		
	C.2	Restore one offsite circuit to OPERABLE status.	24 hours
D. One offsite circuit inoperable. AND One or more required DG(s) in Train A inoperable. OR One or more required DG(s) in Train B inoperable.	--------------------NOTE------------------- Enter applicable Conditions and Required Actions of LCO 3.8.9, "Distribution Systems - Operating," when Condition D is entered with no AC power source to any train. --		
	D.1	Restore offsite circuit to OPERABLE status.	12 hours
	OR		
	D.2	Restore required DG(s) to OPERABLE status.	12 hours

(continued)

ACTIONS (continued)

CONDITION	REQUIRED ACTION		COMPLETION TIME
E. One or more required DG(s) in Train A inoperable. AND One or more required DG(s) in Train B inoperable.	E.1 E.2	Restore required DGs in Train A to OPERABLE status. OR Restore required DGs in Train B to OPERABLE status.	2 hours 2 hours
F. Required Action and Associated Completion Time of Condition A. B, C, D, or E not met.	F.1 AND F.2	Be in MODE 3. Be in MODE 5.	6 hours 36 hours
G. Two offsite circuits inoperable. AND One or more required DG(s) in Train A inoperable. OR One or more required DG(s) in Train B inoperable.	G.1	Enter LCO 3.0.3.	Immediately
H. One offsite circuit inoperable. AND One or more required DG(s) in Train A inoperable. AND One or more required DG(s) in Train B inoperable.	H.1	Enter LCO 3.0.3.	Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.8.1.1	Verify correct breaker alignment and indicated power availability for each offsite circuit.	7 days
SR 3.8.1.2	-----------------------------NOTES--------------------------- 1. Performance of SR 3.8.1.7 satisfies this SR. 2. A modified DG start involving idling and gradual acceleration to synchronous speed may be used for this SR as recommended by the manufacturer. When modified start procedures are not used, the time, voltage, and frequency tolerances of SR 3.8.1.7 must be met. --- Verify each DG starts from standby conditions and achieves steady state voltage ≥ 6800 V and ≤ 7260 V, and frequency ~~≥ 58.8 Hz and ≤ 61.2 Hz~~ 60.0 Hz nominal.	 As specified in Table 3.8.1-1
SR 3.8.1.3	-----------------------------NOTES--------------------------- 1. DG loadings may include gradual loading as recommended by the manufacturer. 2. Momentary transients outside the load range do not invalidate this test. 3. This Surveillance shall be conducted on only one DG at a time. 4. This SR shall be preceded by and immediately follow without shutdown a successful performance of SR 3.8.1.2 or SR 3.8.1.7. --- Verify each DG is synchronized and loaded and operates for ≥ 60 minutes at a load ≥ 3960 kW and ≤ 4400 kW.	 As specified in Table 3.8.1-1
SR 3.8.1.4	Verify each skid mounted day tank contains ≥ 218.5 gal of fuel oil.	31 days

(continued)

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
SR 3.8.1.5	Check for and remove accumulated water from each skid mounted day tank.	31 days
SR 3.8.1.6	Verify the fuel oil transfer system operates to automatically transfer fuel oil from 7 day storage tank to the skid mounted day tank.	31 days
SR 3.8.1.7	Verify each DG starts from standby condition and achieves in ≤ 10 seconds, voltage ≥ 6800 V, and frequency ≥ 58.8 Hz. Verify after DG fast start from standby conditions that the DG achieves steady state voltage ≥ 6800 V and ≤ 7260 V, and frequency ≥ ~~58.8~~ **59.8** Hz and ≤ ~~61.2~~ **60.1** Hz.	184 days
SR 3.8.1.8	-------------------------------NOTE------------------------------ This Surveillance shall not be performed in MODE 1 or 2. However, credit may be taken for unplanned events that satisfy this SR. -- Verify automatic and manual transfer of each 6.9 kV shutdown board power supply from the normal offsite circuit to each alternate offsite circuit.	 18 months

(continued)

SURVEILLANCE REQUIREMENTS (continued)

	SURVEILLANCE	FREQUENCY
SR 3.8.1.9	------------------------------NOTES--------------------------- 1. This Surveillance shall not be performed in MODE 1 or 2. However, credit may be taken for unplanned events that satisfy this SR. 2. If performed with the DG synchronized with offsite power, it shall be performed at a power factor ≥ 0.8 and ≤ 0.9. --- Verify each DG rejects a load greater than or equal to its associated single largest post-accident load, and: a. Following load rejection, the frequency is ≤ 66.75 Hz; b. Within 3 seconds following load rejection, the voltage is ≥ 6555 V and ≤ 7260 V; and c. Within 4 seconds following load rejection, the frequency is ≥ 58.8 Hz and ≤ 61.2 Hz.	18 months
SR 3.8.1.10	------------------------------NOTE---------------------------- This Surveillance shall not be performed in MODE 1 or 2. However, credit may be taken for unplanned events that satisfy this SR. --- Verify each DG operating at a power factor ≥ 0.8 and ≤ 0.9 does not trip and voltage is maintained ≤ 8880 V during and following a load rejection of ≥ 3960 kW and ≤ 4400 kW and ≥ 2970 kVAR and ≤ 3300 kVAR.	18 months

(continued)

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
SR 3.8.1.11	------------------------------NOTE---------------------------- This Surveillance shall not be performed in MODE 1, 2, 3, or 4. However, credit may be taken for unplanned events that satisfy this SR. ---	
	Verify on an actual or simulated loss of offsite power signal: a. De-energization of emergency buses; b. Load shedding from emergency buses; c. DG auto-starts from standby condition and: 1. energizes permanently connected loads in ≤ 10 seconds, 2. energizes auto-connected shutdown loads through automatic load sequencer, 3. maintains steady state voltage ≥ 6800 V and ≤ 7260 V, 4. maintains steady state frequency ≥ ~~58.8~~ **59.8** Hz and ≤ ~~61.2~~ **60.1** Hz, and 5. supplies permanently connected and auto-connected shutdown loads for ≥ 5 minutes.	18 months

(continued)

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
SR 3.8.1.12	-----------------------------NOTE---------------------------- This Surveillance shall not be performed in MODE 1 or 2. However, credit may be taken for unplanned events that satisfy this SR. --- Verify on an actual or simulated Engineered Safety Feature (ESF) actuation signal each Unit 2 DG auto-starts from standby condition and: a. In ≤ 10 seconds after auto-start and during tests, achieves voltage ≥ 6800 V and frequency ≥ 58.8 Hz; b. After DG fast start from standby conditions the DG achieves steady state voltage ≥ 6800 V and ≤ 7260 V, and frequency ≥ ~~58.8~~ **59.8** Hz and ≤ ~~61.2~~ **60.1** Hz. c. Operates for ≥ 5 minutes; d. Permanently connected loads remain energized from the offsite power system; and e. Emergency loads are energized from the offsite power system.	18 months
SR 3.8.1.13	-----------------------------NOTE---------------------------- This Surveillance shall not be performed in MODE 1 or 2. However, credit may be taken for unplanned events that satisfy this SR. --- Verify each DG's automatic trips are bypassed on automatic or emergency start signal except: a. Engine overspeed; and b. Generator differential current	18 months

(continued)

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
SR 3.8.1.14	-----------------------------NOTES-------------------------- 1. Momentary transients outside the load and power factor ranges do not invalidate this test. 2. For performance of this test in MODE 1, 2, 3 or 4, three DGs must be maintained operable and in a standby condition. 3. Credit may be taken for unplanned events that satisfy this SR. --- Verify each DG operating at a power factor $\geq$ 0.8 and $\leq$ 0.9 operates for $\geq$ 24 hours: a. For $\geq$ 2 hours loaded $\geq$ 4620 kW and $\leq$ 4840 kW and $\geq$ 3465 kVAR and $\leq$ 3630 kVAR; and b. For the remaining hours of the test loaded $\geq$ 3960 kW and $\leq$ 4400 kW and $\geq$ 2970 kVAR and $\leq$ 3300 kVAR.	18 months
SR 3.8.1.15	-----------------------------NOTES-------------------------- This Surveillance shall be performed within 5 minutes of shutting down the DG after the DG has operated $\geq$ 2 hours loaded $\geq$ 3960 kW and $\leq$ 4400 kW. Momentary transients outside of load range do not invalidate this test. --- Verify each DG starts and achieves, in $\leq$ 10 seconds, voltage $\geq$ 6800 V, and frequency $\geq$ 58.8 Hz. Verify after DG fast start from standby conditions that the DG achieves steady state voltage $\geq$ 6800 V and $\leq$ 7260 V, and frequency $\geq$ ~~58.8~~ **59.8** Hz and $\leq$ ~~61.2~~ **60.1** Hz.	18 months

(continued)

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
SR 3.8.1.16	------------------------------NOTE---------------------------- This Surveillance shall not be performed in MODE 1, 2, 3, or 4. However, credit may be taken for unplanned events that satisfy this SR. --- Verify each DG: a. Synchronizes with offsite power source while loaded with emergency loads upon a simulated restoration of offsite power; b. Transfers loads to offsite power source; and c. Returns to ready-to-load operation.	18 months
SR 3.8.1.17	------------------------------NOTE---------------------------- This Surveillance shall not be performed in MODE 1, 2, 3, or 4. However, credit may be taken for unplanned events that satisfy this SR. --- Verify, with each Unit 2 DG operating in test mode and connected to its bus, an actual or simulated ESF actuation signal overrides the test mode by: a. Returning DG to ready-to-load operation; and b. Automatically energizing the emergency load from offsite power.	18 months

(continued)

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
SR 3.8.1.18	-----------------------------NOTE---------------------------- This Surveillance shall not be performed in MODE 1, 2, 3, or 4. However, credit may be taken for unplanned events that satisfy this SR. --- Verify the time delay setting for each sequenced load block is within limits for each accident condition and non-accident condition load sequence.	18 months
SR 3.8.1.19	-----------------------------NOTE---------------------------- This Surveillance shall not be performed in MODE 1, 2, 3, or 4. However, credit may be taken for unplanned events that satisfy this SR. --- Verify on an actual or simulated loss of offsite power signal in conjunction with an actual or simulated ESF actuation signal: a. De-energization of emergency buses; b. Load shedding from emergency buses; and c. DGs of the same power train auto-start from standby condition and: 1. energizes permanently connected loads in ≤ 10 seconds, 2. energizes auto-connected emergency loads through load sequencer, 3. achieves steady state voltage: ≥ 6800 V and ≤ 7260 V, 4. achieves steady state frequency ≥ ~~58.8~~ **59.8** Hz and ≤ ~~61.2~~ **60.1** Hz, and 5. supplies permanently connected and auto-connected emergency loads for ≥ 5 minutes.	18 months

(continued)

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
SR 3.8.1.20	Verify during idle operation that any automatic or emergency start signal disables the idle start circuitry and commands the engine to full speed.	18 months
SR 3.8.1.21	Verify when started simultaneously from standby condition, each DG achieves, in ≤ 10 seconds, voltage ≥ 6800 V and frequency ≥ 58.8 Hz. Verify after DG fast start from standby conditions that the DG achieves steady state voltage ≥ 6800 V and ≤ 7260 V, and frequency ≥ ~~58.8~~ **59.8** Hz and ≤ ~~61.2~~ **60.1** Hz.	10 years

Table 3.8.1-1 (page 1 of 1)
Diesel Generator Test Schedule

NUMBER OF FAILURES IN LAST 25 VALID TESTS[(a)]	FREQUENCY
≤ 3	31 days
≥ 4	7 days[(b)] (but no less than 24 hours)

(a) Criteria for determining number of failures and valid tests shall be in accordance with Regulatory Position C.2.1 of Regulatory Guide 1.9, Revision 3, where the number of tests and failures is determined on a per DG basis.

(b) This test frequency shall be maintained until seven consecutive failure free starts from standby conditions and load and run tests have been performed. If, subsequent to the 7 failure free tests, 1 or more additional failures occur, such that there are again 4 or more failures in the last 25 tests, the testing interval shall again be reduced as noted above and maintained until 7 consecutive failure free tests have been performed.

ATTACHMENT 2

Proposed TS Bases Changes (Mark-Ups) for WBN Unit 2

(For Information Only)

SURVEILLANCE REQUIREMENTS (continued)

Where the SRs discussed herein specify voltage and frequency tolerances, the following is applicable. 6800 volts is the minimum steady state output voltage and the 10 seconds transient value. 6800 volts is 98.6% of the nominal bus voltage of 6900 V corrected for instrument error and is the upper limit of the minimum voltage required for the DG supply breaker to close on the 6.9 kV shutdown board. The specified maximum steady state output voltage of 7260 V is 110% of the nameplate rating of the 6600 V motors. The specified 3 second transient value of 6555 V is 95% of the nominal bus voltage of 6900 V. The specified maximum transient value of 8880 V is the maximum equipment withstand value provided by the DG manufacturer. The specified minimum and maximum transient frequencies of the DG are 58.8 Hz and 61.2 Hz, respectively. ~~These values are equal to ± 2% of the 60 Hz nominal frequency and are derived from the recommendations given in Regulatory Guide 1.9 (Ref. 3).~~

INSERT

The steady state minimum and maximum frequency values are 59.8 Hz and 60.1 Hz. These values ensure that the safety related plant equipment powered from the DGs is capable of performing its safety functions.

SR 3.8.1.1

This SR ensures proper circuit continuity for the offsite AC electrical power supply to the onsite distribution network and availability of offsite AC electrical power. The breaker alignment verifies that each breaker is in its correct position to ensure that distribution buses and loads are connected to their preferred power source, and that appropriate independence of offsite circuits is maintained. The 7 day Frequency is adequate since breaker position is not likely to change without the operator being aware of it and because its status is displayed in the control room.

SR 3.8.1.2 and SR 3.8.1.7

These SRs help to ensure the availability of the standby electrical power supply to mitigate DBAs and transients and to maintain the plant in a safe shutdown condition. ...

SURVEILLANCE REQUIREMENTS

SR 3.8.1.2 and SR 3.8.1.7 (continued)

In order to reduce stress and wear on diesel engines, the manufacturer recommends a modified start in which the starting speed of DGs is limited, warmup is limited to this lower speed, and the DGs are gradually accelerated to synchronous speed prior to loading. These start procedures are the intent of Note 2, which is only applicable when such modified start procedures are recommended by the manufacturer.

SR 3.8.1.7 requires that, at a 184 day Frequency, the DG starts from an actual or simulated loss of offsite power signal and achieves required voltage and frequency within 10 seconds. The 10 second start requirement supports the assumptions of the design basis LOCA analysis in the FSAR, Section 15 (Ref. 5). Starting the DG from an emergency start signal ensures the automatic start relays are cycled (de-energized) on a 184 day Frequency.

The 10 second start requirement is not applicable to SR 3.8.1.2 (See Note 2.) when a modified start procedure as described above is used.

INSERT →

During this testing the diesel is not in an accident mode and the frequency is controlled by the operator instead of the governor's accident speed reference.

If a modified start is not used, the 10 second start requirement of SR 3.8.1.7 applies. Stable operation at the nominal voltage and frequency values is also essential to establishing DG OPERABILITY, but a time constraint is not imposed. This is because a typical DG will experience a period of voltage and frequency oscillations prior to reaching steady state operation if these oscillations are not dampened out by load application. This period may extend beyond the 10 second acceptance criteria and could be a cause for failing the SR. In lieu of a time constraint in the SR, WBN will monitor and trend the actual time to reach steady state operation as a means of ensuring there is no voltage regulator or governor degradation which could cause a DG to become inoperable.

Since SR 3.8.1.7 requires a 10 second start, it is more restrictive than SR 3.8.1.2, and it may be performed in lieu of SR 3.8.1.2. This is the intent of Note 1 of SR 3.8.1.2...

(continued)

The changes to the TS LCO SR 3.8.1.2, 3.8.1.7, 3.8.1.11, 3.8.1.12, 3.8.1.15, 3.8.1.19, and 3.8.1.21 and to TS Bases Section 3.8.1 will be incorporated in a future revision of the WBN Unit 2 developmental TS.

Enclosure 3
Response to Supplemental Safety Evaluation Report (SSER) 22, Open Item 32

List of Regulatory Commitments

Regulatory Commitments	
Commitment	**Due Date**
The TVA WBN Unit 2, NPG System Description Document, NPG-SDD-WBN2-82-4002, "Standby Diesel Generator System" shall be revised to describe the DG frequency and voltage governor setting methodology. The DG will be set within a speed band which is equivalent to a frequency band of 59.95 Hz ± 0.05 Hz. Likewise the DG will be set within a voltage band of 6950 V, +50 V and -25 V. These frequency and voltage bands are the Acceptable As Found Tolerance (AAF). In the event that the speed (frequency) or voltage is found outside of their setting band (i.e., AAF), the 'as-found' values will be reset within the setting band, and the 'as-found' values will be entered into the WBN corrective action program (CAP) for evaluation of performance and trending.	Prior to WBN Unit 2 receiving an operating license.