TENNESSEE VALLEY AUTHORITY
CHATTANOOGA, TENNESSEE 37401
400 Chestnut Street Tower II

February 16, 1985

Director of Nuclear Reactor Regulation
Attention: Ms. E. Adensam, Chief
Licensing Branch No. 4
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Ms. Adensam:

In the Matter of the Application of	)	Docket Nos. 50-390
Tennessee Valley Authority	)	50-391

Watts Bar technical specification 3/4.8.1 defines the operability and availability requirements for the diesel generator (DG) units. With any one of the four existing DG units declared inoperable, the technical specifications require restoration of the DG unit to an operable status within 72 hours or unit(s) shutdown.

TVA has designed and constructed an equivalent additional diesel generator unit (ADGU) that can be used to replace any of the four existing diesel generator units if one should be out of service. The availability of the ADGU will preclude loss of production by strengthening the plant against a long-term loss of offsite power, therefore, improving overall safety in plant operations.

The enclosed document provides a detailed description of the ADGU's structural, mechanical, and electrical equipment, and testing program. The ADGU will be locked out until NRC-staff approval. TVA intends to implement the ADGU for unit 1 by startup following the first refueling outage and for unit 2 by its respective fuel load date.

The drawings referenced in the enclosure as being attached are to be provided to the NRC Project Manager under separate cover.

A001
1/1

Director of Nuclear Reactor Regulation February 16, 1985

If you have any questions concerning this matter, please get in touch with D. B. Ellis of my staff at FTS 858-2681.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

R. H. Shell

R. H. Shell
Nuclear Engineer

Sworn to and subscribed before me
this 15th day of February, 1985.

Bryant M. Lowery
Notary Public
My Commission Expires 4/8/86

Enclosure
cc: U.S. Nuclear Regulatory Commission (Enclosure with drawings)
Region II
Attn: Dr. J. Nelson Grace, Regional Administrator
101 Marietta Street, NW, Suite 2900
Atlanta, Georgia 30323

WATTS BAR NUCLEAR PLANT

ADDITIONAL DIESEL GENERATOR

SUBMITTAL TO NRC

ABBREVIATIONS

ADGU - Additional Diesel Generator Unit

ANS - American Nuclear Society

ANSI - American National Standards Institute

AMSE - American Society of Mechanical Engineers

ASTM - American Society of Testing Materials

DEMA - Diesel Engine Manufacturers Association

DG - Diesel Generator

DGU - Diesel Generator Unit

EDGU - Existing Diesel Generator Unit

ERCW - Essential Raw Cooling Water

FSAR - Final Safety Analysis Report

GDC - General Design Criteria Appendix A to 10CFR Part 50

HPFP - High Pressure Fire Protection

IEEE - Institute of Electrical and Electronics Engineers

MCR - Main Control Room

MOV - Motor-Operated Valve

NEMA - National Electric Manufacturers Association

NFPA - National Fire Protection Association

OBE - Operating Basis Earthquake

SQN - Sequoyah Nuclear Plant

SSE - Safe Shutdown Earthquake

TVA - Tennessee Valley Authority

WBN - Watts Bar Nuclear Plant

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WATTS BAR NUCLEAR PLANT
ADDITIONAL (FIFTH) DIESEL GENERATOR

GENERAL DESCRIPTION

This document describes the installation of an additional diesel generator unit (ADGU) to be used to replace an existing diesel generator unit (EDGU) for Watts Bar Nuclear Plant (WBN) units 1 and 2 when one of the EDGUs is out of service in order to satisfy the technical specification requirement for DGU availability. The design requires that those systems and subsystems which are necessary to ensure operability of the ADGU (designated as TVA system C-S) will be operable whenever it is used as a substitute for an EDGU. This document contains a detailed description of the ADGU building and structures (Appendix A), a description of the ADGU electrical and mechanical equipment (Appendix B) and a description of the testing program for the ADGU (Appendix C).

REASON FOR THE CHANGE

As part of the plant's licensing basis, all four EDGUs are required during two-unit operation to mitigate a postulated licensing design basis accident while assuming a single failure. When any one of the four EDGUs (1A-A, 2A-A, 1B-B, 2B-B) is declared inoperable, the action statements of the WBN draft technical specifications allow only 72 hours to return all four DGUs to operability or both units must be shutdown. This time constraint limits the magnitude of any maintenance and/or repair that can be completed while either nuclear unit is at power. Operating experience at Sequoyah Nuclear Plant (SQN) has indicated that there is a significant probability of exceeding this 72-hour limit and incurring the cost of lost production due to a forced shutdown.

The availability of an ADGU will preclude this loss of production by providing an alternate DGU which can be substituted for any EDGU. This will also strengthen the plant against a postulated long-term loss of offsite power, thereby improving overall plant safety.

DESIGN DESCRIPTION AND JUSTIFICATION FOR THE CHANGE

TVA has designed and constructed the ADGU in accordance with the applicable design criteria as noted in the design description in Appendices A and B. This ADGU is equivalent to the existing trained DGUs.

The basic concept of the design is to make maximum use of the existing class 1E components. This minimizes the amount of new controls in the main control room (MCR), and it provides the ADGU with control and accident logic circuits which are included in the plant surveillance program.

The control switching required to substitute the ADGU for a trained DGU will require the transfer of the control and annunciation cables at two isolation points. At the disabled DGU's control and annunciator distribution panels located in the diesel generator building (reference TVA drawing 15N210-1, attached) the control and annunciation cables required for operation of the disabled DGU will be switched to those cables required for the operation of the ADGU. Sketch 1 (attached) depicts the cable switching arrangements. As an example, if the 1A-A DGU is inoperable, the operators would disconnect the 48 pin, keyed, screw-type connectors (depicted on sketch 1 as J1-N and P1) from the 1A-A alignment on the 1A-A control and annunciator distribution panels and reconnect them to the connectors (depicted on sketch 1 as J1-S) required for the ADGU alignment which are located on the same panel. At the ADGU's control and annunciator distribution panels located in the ADG building (reference TVA drawing 15N211-2, attached), the operators will connect the ADGU's control to the 48 pin, keyed, screw-type connectors so that it may replace DGU 1A-A (depicted on sketch 1 as J1-1A and P1). In the above example, the power circuit switching requires the manual alignment of the transfer switch located in the diesel generator building (reference TVA drawing 15N210-1, attached) and the inserting of the power air circuit breaker into panel E of the 6.9-kV DG building C-S (reference TVA drawing 15E500-2, attached) located in the ADGU building. Sketch 2 (attached) depicts the power circuit switching arrangements. With the controls, annunciators, transfer switches, and circuit breaker aligned as described in the example above the ADGU is an exact functional replacement for the disabled DGU.

When all the control and annunciator connectors are in their correct positions, a circuit is completed and an annunciator in the MCR notifies the operator that the ADGU has replaced the disabled DGU.

This design provides separation of trained equipment by energizing only one set of ADGU control connectors at a time and providing two isolation points to preclude a single failure from affecting all four DGUs.

The ADGU will use essential raw cooling water (ERCW) to cool the engine during operation. The logic circuitry for the ERCW supply valve is provided by the switching procedure outlined above. This ensures that upon receipt of an automatic DGU start signal, the ERCW valves will open to provide cooling water. Since the output of the logic circuitry for the inoperable EDGU is used for the ADGU, the ERCW valves for the inoperable EDGU will not automatically open. This will preclude supplying ERCW to an inoperable DGU and possibly impacting the capability of the ERCW to provide a heat sink for other safety-related equipment.

The ERCW valves for the inoperable DGU may be opened manually to supply cooling water during testing prior to returning the unit to service. TVA will provide administrative controls to ensure that the ERCW supply valves to the inoperable DGU will be closed when the other four DGUs have started unless ERCW capacity is sufficient to provide cooling to all safety-related loads.

Prior to initial use as a substitute for any EDGU, the ADGU will be tested in a program similar to that used to verify the four EDGUs. The preoperational testing program described in Appendix C will provide the baseline verification of the ADGU design adequacy.

INTERTIES TO BE COMPLETED BEFORE UNIT 1 FUEL LOADING

Mechanical Interties

Mechanical interties which have been completed and are planned to be completed before unit 1 fuel loading are shown on the attached TVA drawings.

ERCW	47W845-1, -5
HPFP	47W832-1
Fuel Oil	47W840-1, -2
Potable Water	47W835-1
Service Air	47W836-1
Station Drainage	47W853-10

Electrical Interties

Electrical interties which have been completed and are planned to be completed before unit 1 fuel loading are shown on the attached TVA drawings:

45W760-82-1 through -10 45W760-211-4

The control, annunciation, and power circuit interfaces between the DGUs and their controls and shutdown boards depicted on the above drawings will be functionally tested before unit 1 operation to ensure no loss of operability or degradation of safety exists.

SUMMARY

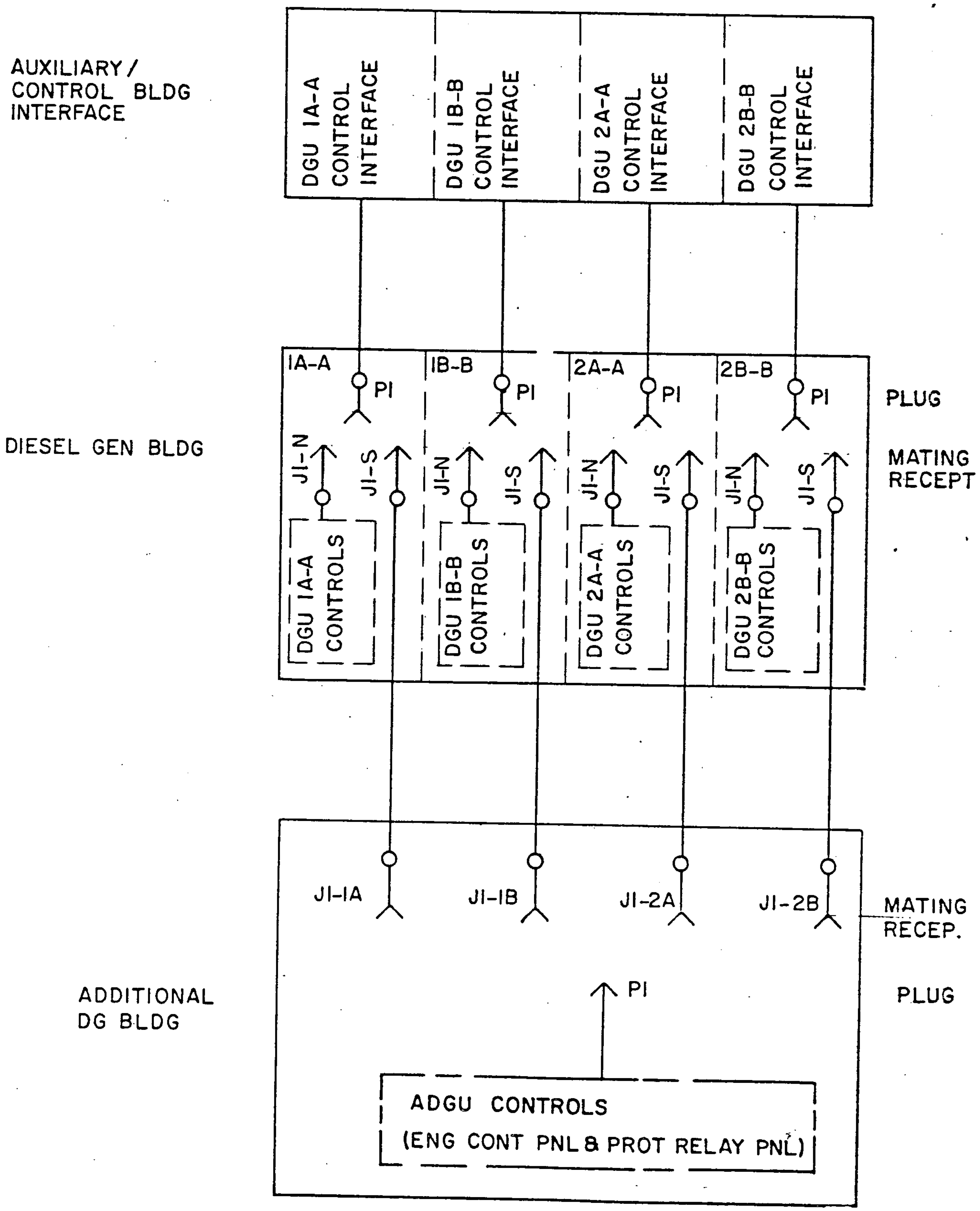
In summary, TVA believes that the ADGU will improve availability of onsite ac power systems, and thereby decrease both the time the plant will operate under LCOs regarding the onsite ac power supplies and the possibility of a one- or two-unit shutdown. It will also, in the same way, improve the safe operations of the plant.

The design and construction of the ADGU structure, systems and components meet applicable regulatory requirements.

The ADGU systems and components including electrical control will be tested to ensure that it will operate as designed and will be included in the normal surveillance program to ensure operability upon demand (after it has replaced a DGU). Connections of the ADGU to the onsite power and control systems will be checked to ensure function each time the ADGU replaces a DGU.

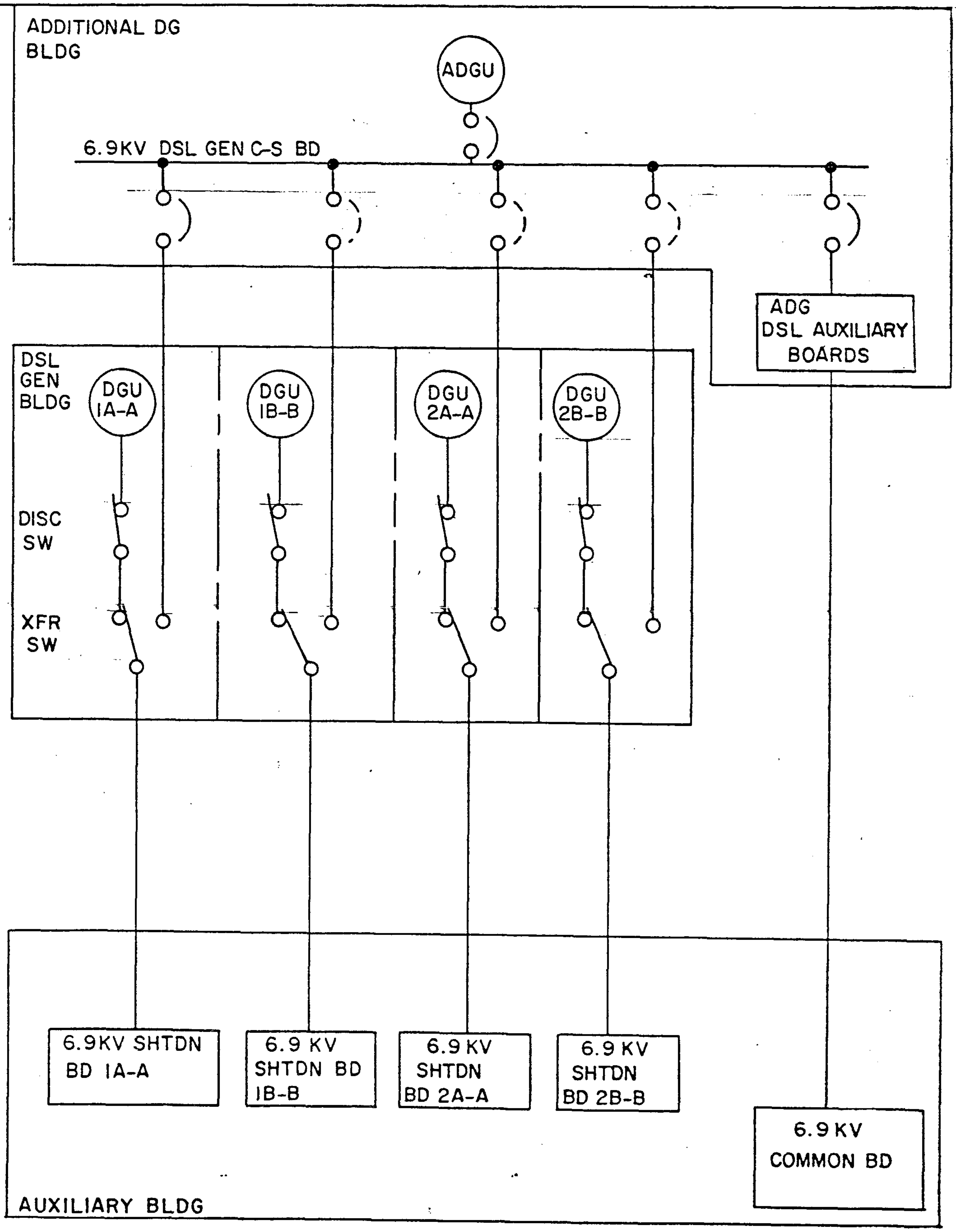
SKETCH I

TYPICAL SWITCHOVER CONFIGURATION
FOR ADDITIONAL DIESEL GENERATOR
CONTROLS AND ANNUNCIATION



SKETCH 2

SWITCHOVER CONFIGURATION FOR
ADDITIONAL DIESEL GENERATOR
6.9 KV POWER



APPENDIX A

TENNESSEE VALLEY AUTHORITY
WATTS BAR NUCLEAR PLANT UNITS 1 AND 2

DESCRIPTION OF THE STRUCTURAL DESIGN
FOR THE ADDITIONAL DIESEL GENERATOR UNIT

APPENDIX A

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DESCRIPTION OF THE STRUCTURAL DESIGN FOR THE ADDITIONAL DIESEL GENERATOR UNIT

The additional diesel generator unit (ADGU) at Watts Bar Nuclear Plant (WBN) is located in a separate building. The location of the building in relation to other structures is shown on Figure A1. The applicable design criteria employed in design and construction of the ADGU building is given below.

1.0 ADDITIONAL DIESEL GENERATOR BUILDING

1.1 General Description

The additional DG building is a pile-supported, two-story-rectangular box-type concrete structure. The top of the base mat is at elevation 742.0.

The building is a category I structure consisting of both reinforced concrete and structural steel. The major structural components are listed below:

1. Steel-lined fuel oil storage tanks are encased in reinforced concrete.

2. A reinforced concrete base slab which also serves as the encasement for the fuel oil storage tanks. The slab is supported on end-bearing steel H-piles.

3. Interior and exterior reinforced concrete walls.

4. Reinforced concrete floor and roof slabs.

5. End-bearing steel H-piles.

1.2 Base Slab Design

The base slab is pile supported. The slab was designed for a uniform live load except where equipment weights dictated a higher value. Equipment loads due to vibration or earthquake acceleration that were transmitted to the slab from anchor bolts were also taken into consideration. In addition, the slab was designed for hydrostatic pressures.

The base slab is a rectangular cast-in-place reinforced concrete structure with diesel fuel storage tanks embedded in it and is supported by piles bearing on rock.

1.3 Roof Slab Design

The roof slab was designed for live, seismic, and tornado loads.

1.4 Floor Slab

The floor slab is a poured-in-place reinforced concrete slab designed to carry and transmit the floor loads to the building walls. The slab was designed for a uniform live load.

1.5 Fuel Oil Storage Tanks

Four interconnected fuel oil storage tanks are located in the ADGU building.

1.5.1 Materials

Each tank consists of a carbon steel liner encased in the concrete base slab. The liner is a minimum of 1/4-inch thick to resist corrosion and stresses due to handling and construction.

1.5.2 Fabrication, Testing, and Stamping

Joint welding procedures used in fabrication of the steel liner were qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX, prior to use by TVA or the fabricator. 100-percent magnetic particle examination of all welds exposed to the contents of the lined vessel was made using properly qualified personnel and in accordance with ASME, Section VIII. Also, each steel liner was subjected to a standard hydrostatic test in accordance with ASME, Section VIII.

1.5.3 Design

The steel liner serves no other function except to maintain leaktightness and, therefore, was designed in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, Division I. In addition, the liner was designed to prevent buckling of the steel shell due to the following external loads.

a. Hydrostatic pressure from underground water.
b. Shrinkage of the concrete encasement during construction.
c. Expansion or contraction due to temperature differentials.

1.5.4 Flammable Liquids Storage Requirements

The fuel oil storage tanks meet the requirements of the National Fire Protection Association (NFPA) Code 30 which applies to fuel oil storage tanks supplying underground storage of a class II liquid (diesel fuel).

1.6 Exterior Walls

The building was designed for tornado venting. However, the exterior walls were designed for tornado, wind, and seismic loads.

1.7 Equipment Door

The equipment door is composed of a structural steel frame and covered on both sides with a steel-skin plate.

Precast concrete bulkheads are placed in front of the equipment doors to provide protection from tornado-generated missiles.

1.8 Allowable Settlement

The building was designed to accommodate a settlement of 2 inches, with a differential settlement of 1 inch over a 96-foot structure length.

1.9 End-Bearing Steel H-Piles

The piles were designed to withstand and transmit to rock the effects of the design loads and conditions.

1.10 Seismic Analysis

The structure was analyzed for the effects of the operating basis earthquake (OBE) and the safe shutdown earthquake (SSE).

1.11 Materials, Quality Control, and Special Construction Techniques

1.11.1 Structural Steel

Rolled shapes, plates, and bars meet Specification ASTM A 36. Fabricated high-strength steel meets Specificaton ASTM A 572 and bolting meets Specification ASTM A 325 or A 490. Anchor bolts meet ASTM A 307 or A 36 steel.

1.11.2 Reinforcing Steel

The yield strength of reinforcing steel used in the building is 60,000 lb/in^2 (ASTM A 615, grade 60) or greater.

1.11.3 Concrete

The compressive strength of concrete is 3000 lb/in^2 or greater.

1.11.4 Quality Control and Special Construction Techniques

See section 3.8.4.6 of the WBN Final Safety Analysis Report (FSAR).

2.0 LOADS - DEFINITIONS AND NOMENCLATURE

2.1 Definition of Load Terms for Category I Structures

The following terms are used in the load combination equations for category I structures:

Normal loads, which are those loads to be encountered during normal plant operation and shutdown, include:

D - Dead loads or their related internal moments and forces including any permanent equipment loads; all hydrostatic loads; and earth loads applied to horizontal surfaces.

L - Live loads or their related internal moments and forces including any movable equipment loads and other loads which vary with intensity and occurrence, such as lateral soil pressures.

200 lb/ft^2 or equipment load (floors)
50 lb/ft^2 on roof

L_c - Construction live load = 50 lb/ft^2

T_o - Thermal effects and loads during normal operating or shutdown conditions, based on the most critical transient or steady-state condition.

R_o - Pipe reactions during normal operating or shutdown conditions, based on the most critical transient or steady-state condition.

Severe environmental loads include:

E - Loads generated by the OBE.

W - Loads generated by the design wind specified for the plant. See section 3.3 of FSAR.

Extreme environmental loads include:

E' - Load generated by the SSE.

F - Hydrostatic load from design basis flood.

W_t - Loads generated by the design tornado specified for the plant. Tornado loads include loads due to the tornado wind pressure, and to tornado-generated missiles.

Where:

$W_t = W_w$ (tornado wind) (see section 3.3 of FSAR).

$W_t = W_m$ (tornado missile, see table 2-1).

$W_t = W_w + W_m$

2.2 Load Combinations

2.2.1 Concrete Structures

a. For service load conditions, the strength design method was used and the following load combinations were considered.

1. $U = 1.4\ D + 1.7\ L$
2. $U = 1.4\ D + 1.7\ L + 1.9\ E$
3. $U = 1.4\ D + 1.7\ L + 1.7\ W$

If thermal stresses due to T_o and R_o are present, the following combinations were also considered.

1a. $U = (0.75)\ (1.4\ D + 1.7\ L + 1.7\ T_o + 1.7\ R_o)$
2a. $U = (0.75)\ (1.4\ D + 1.7\ L + 1.9\ E + 1.7\ T_o + 1.7\ R_o)$
3a. $U = (0.75)\ (1.4\ D + 1.7\ L + 1.7\ W + 1.7\ T_o + 1.7\ R_o)$

Both cases of L having its full value or being completely absent were checked. In addition, the following combinations were considered.

2a'. $U = 1.2\ D + 1.9\ E$
3a'. $U = 1.2\ D + 1.7\ W$

Where D or L reduce the effect of the loads given above, the corresponding coefficients were taken as 0.90 for D and zero for L. The vertical pressure of liquids was considered as dead load with due regard to variation in liquid depth.

b. For factored load conditions, which represent extreme environmental, abnormal, abnormal/severe environmental and abnormal/extreme environmental conditions, the strength design method was used and the following load combinations were considered.

4. $U = D + L + T_o + R_o + E'$
5. $U = D + L + T_o + R_o + W_t$

c. Other load conditions:

9. $U = 1.4\ D + 1.4\ L_c$
10. $U = D + L + F$

2.2.2 Steel Structures

a. For service load conditions, the elastic working stress design methods for Part 1 of the AISC specifications were used and the following load combinations were considered.

1. $S = D + L$
2. $S = D + L + E$
3. $S = D + L + W$

If thermal stresses due to T_o and R_o are present, the following combinations were also considered:

1a. $1.5S = D + L + T_o + R_o$
2a. $1.5S = D + L + T_o + R_o + E$
3a. $1.5S = D + L + T_o + R_o + W$

Both cases of L having its full value or being completely absent were checked.

b. For factored load conditions, the following load combinations were considered:

4. $1.6S = D + L + T_o + R_o + E'$
5. $1.6S = D + L + T_o + R_o + W_t$

In the above factored load combinations, thermal loads were neglected when it was shown that they are secondary and self-limiting in nature and where the material is ductile.

2.3 Uplift, Overturning, Sliding, and Flotation

2.3.1 Notation

The following terms were used in calculation of loads for uplift, overturning, sliding, and flotation:

D, E, W, E', W_t	As defined in section 2.1
H	Lateral earth pressure
F'	Buoyant force from design basis flood
F_b	Buoyant force from normal ground water

2.3.2 Requirements of Category I Structures

The following minimum factors apply for the load conditions given.

Load Combination	Minimum Factors of Safety Overturning	Sliding	Flotation
D + H + E	1.5	1.5	---
D + H + W	1.5	1.5	---
D + H + E'	1.1	1.1	---
D + H + W_t	1.1	1.1	---
D + F'	---	---	1.1
D + F_b	---	---	1.5

TABLE 2-1

PARAMETERS FOR TORNADO-GENERATED MISSILES

Missile Description	Weight (lb)	Cross Section	Length (ft)	Horizontal Velocity (ft/sec)
Wooden plank	115	4" x 12"	12	272
Steel rod	9	1" dia.	3	167
6" schedule 40 pipe	287	6" dia.	15	171
12" schedule 40 pipe	750	12" dia.	15	54
Utility pole	1124	13-1/2" dia.	35	180
Automobile	4000	6.5' x 4.3'	16.5	194

Note: Vertical velocities of 70 percent of the postulated horizontal velocities are acceptable except for the 1-inch steel rod which shall have a vertical velocity equal to its horizontal velocity (167 ft/sec). These missiles are capable of striking in any horizontal or downward direction and at all elevations.

3.0 SEISMIC QUALIFICATION OF EQUIPMENT

Mechanical and electrical equipment for the WBN ADGU will be seismically qualified for both OBE and SSE response spectra resulting from analysis of the ADGU building.

3.1 Seismic Design Criteria

Applicable seismic design criteria include:

1. WB-DC-40-31.2, R2, "Seismic Qualification of Category I Fluid System Components and Category I Electrical or Mechanical Equipment."

2. WB-DC-40-31.6, R0, "Seismically Qualifying Tanks and Reservoirs and Their Supports."

3. WB-DC-40-31.11, R0 "Support of Lighting Fixtures in Category I Structures."

4. WB-DC-40-31.12, R1, "Seismic Qualification of Category I and I(L) Valves and Other Inline Fluid System Components."

5. WB-DC-40-31.13, R0, "Seismic Qualification of Category I(L) Fluid System Components and Electrical or Mechanical Equipment."

These design criteria define minimum requirements for seismic qualification of the category I and I(L) equipment located in the additional DG building at WBN.

Seismic qualification of the equipment has been or will be verified. Permanent documentation of this qualification will be retained in TVA files.

4.0 APPLICABLE CODES, STANDARDS, AND SPECIFICATIONS

The following codes, standards, and specifications apply to the design and construction of the ADGU building:

4.1 American Concrete Institute, "Building Code Requirements for Reinforced Concrete," ACI 318-77.

4.2 American Institute of Steel Construction, "Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings," Eighth Edition, effective November 1, 1978.

4.3 ASME Boiler and Pressure Vessel Code, Sections III, VIII, and IX.

4.4 American Society for Testing and Materials, 1975, Annual Book of ASTM Annual Standards.

4.5 Watts Bar Nuclear Plant Final Safety Analysis Report, Chapter 3, "Design of Structures, Components, Equipment, and Systems," Tennessee Valley Authority, Knoxville, Tennessee (see FSAR section 3.8.4.2 for additional applicable codes, standards, and specifications).

4.6 National Fire Protection Code (NFPA) 30.

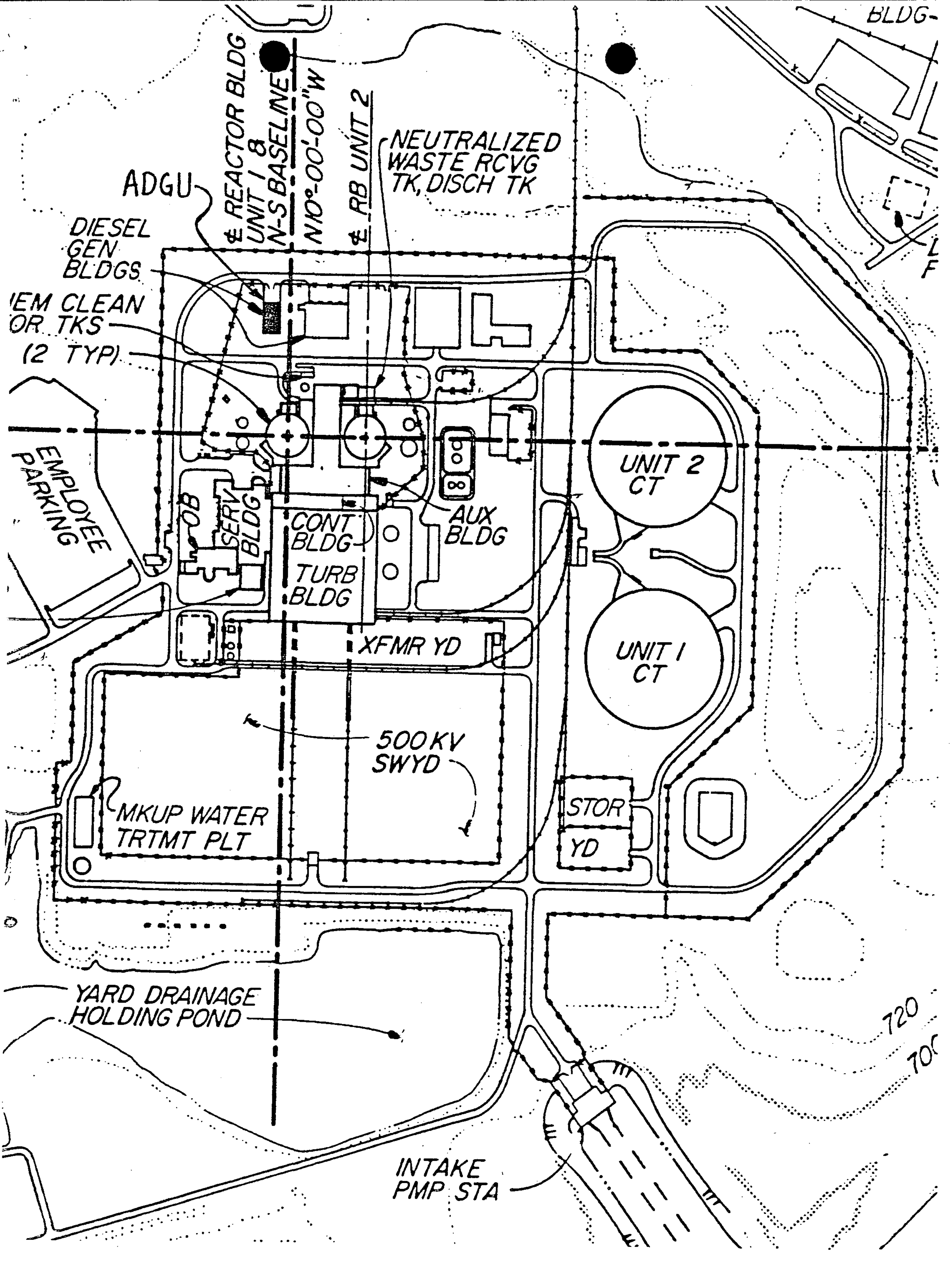
BLDG
ADGU
℄ REACTOR BLDG UNIT 1 & N-S BASELINE
N10°-00'-00"W
℄ RB UNIT 2
NEUTRALIZED WASTE RCVG TK, DISCH TK
DIESEL GEN BLDGS
EM CLEAN OR TKS
(2 TYP)
EMPLOYEE PARKING
OB
SERV BLDG
CONT BLDG
TURB BLDG
AUX BLDG
UNIT 2 CT
UNIT 1 CT
XFMR YD
500 KV SWYD
MKUP WATER TRTMT PLT
STOR YD
YARD DRAINAGE HOLDING POND
INTAKE PMP STA
720
700

Figure A1

APPENDIX B

TENNESSEE VALLEY AUTHORITY
WATTS BAR NUCLEAR PLANT UNITS 1 AND 2

DESCRIPTION OF THE ELECTRICAL POWER SYSTEM
FOR THE ADDITIONAL DIESEL GENERATOR UNIT

APPENDIX B

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DESCRIPTION OF THE ELECTRICAL POWER SYSTEM
FOR THE ADDITIONAL DIESEL GENERATOR UNIT

The ADGU shall serve as a replacement for any one of the EDGUs, therefore it has no train designation until it has been manually aligned (electrically, mechanically, etc.) to replace an EDGU. It will then assume the train requirements of the unit being replaced. Hence, the ADGU shall be considered to be part of the engineered safeguards and vital to plant operation during its mode of operation as described. All ADGU equiment and controls are class 1E per reference 3.3.2. The ADGU and its building were designed and constructed under the Quality Assurance Program per 10CFR50, Appendix B. The design requirements are shown below:

1.0 DESIGN REQUIREMENTS OF ADDITIONAL DIESEL GENERATOR UNIT

1.1 Diesel Generator

1.1.1 General Description of ADGU

This additional diesel engine-driven generator unit is equivalent to the original four units installed at WBN. The ADGU is furnished by Power Systems Division of Morrison-Knudsen and consists of two 16-cylinder engines (make and model No. EMD 16-645E4B) directly connected to a 6.9-kV generator. The ADGU uses a tandem arrangement; that is, each unit consists of two diesel engines with a single generator between them, connected together to form a common shaft. The normal operating speed of the set is 900 rev/min. The unit has a continuous rating of 4400 kW at 0.8 pf and a short-time rating of 4840 kW (2 hours out of 24 hours). The engines of the unit conform to the Diesel Engine Manufacturers Association (DEMA) standard practices.

1.1.2 ADGU Drawings

The ADGU (C-S system) is shown on the single-line diagram of attached drawing 45W728, sheets 1 and 2, and the schematic diagrams on attached drawings 45W760-82, sheets 1 through 22.

1.1.3 Governor

The governor of the ADGU consists of the following:
a. Woodward EGB-13P actuator on each engine.
b. 2301 computer (reverse biased).
c. Frequency pickup.

The Woodward EGB-13P actuator used with the 2301 computer is a proportional governor which moves the fuel rack in inverse proportion to the voltage signal from the computer. There is a governor actuator on each engine electrically connected in series so that the loss in signal to one would also be the loss in signal to the other.

Based upon the input from the generator, the electronic network sends electric signals to the actuators on the two engines. This signal goes to the coils of each actuator that are connected in series so that each coil sees the same electric signal. The terminal shaft of each actuator will move exactly the same amount for each change in signal. This means that the fuel control shaft movement on each engine will be identical.

Attached to the fuel control shaft through an appropriate linkage is an injector rack for each cylinder which by its position meters the fuel injected into its cylinder. This rack is set with a standard factory gauge so that each cylinder will receive the same amount of fuel. Each injector rack is spring loaded to prevent any single injector that may stick from affecting the remaining racks on that engine.

There is a device to provide an alarm signal should two engines of a ADGU receive different amounts of fuel. This device is a synchro device that is given an alarm signal should the difference in the actuator control positions for the two engines exceed a certain tolerance.

The mechanical governor is set to control the unit speed at 930 rev/min rather than the 900 rev/min of the electrical governor. Since the governor's electrical system is reverse biased, a failure in the electrical system would cause the engine speed to increase until it reached the set point of the mechanical governor and at that point the mechanical governor would control the engine.

1.1.4 Accessory Devices

Accessories such as heat exchangers, heaters, oil coolers, oil pumps, sumps, day tank, oil filters, turbochargers, air filters, silencers, exhaust mufflers, air compressors, batteries, battery chargers, and controls are considered to be part of the ADGU.

The diesel engine and generator components are skid-mounted to maintain shaft alignment. Controls are mounted in separate, floor-mounted cabinets and the generator is complete with excitation system. Protection devices are similar to those described in the FSAR (see reference 3.1.1) for the EDGUs.

1.1.5 Lube Oil System

The ADGU is furnished with the engine manufacturer's recommended lube oil system modifications and heavy duty turbochargers.

1.1.6 ADGU Auxiliaries

The ADGU auxiliaries are supplied power from the 480V diesel auxiliary supply board located in the ADGU building on elevation 760.5 (reference TVA drawings 15N211, sheets 2 and 3; 45W733 sheets 1 through 7; and 45W760-215, sheets 1 and 2, attached).

1.1.7 Design for External Hazards

The ADGU will perform its safety function and withstand the design basis events (e.g., safe shutdown earthquake, tornado depressurization, etc.).

1.2 Fuel System

Each engine of the tandem pair has its own complete fuel system, including a day tank having a capacity of at least 1-1/2 hours at full load or overload conditions. Each system is capable of supplying adequate fuel to the diesel engine under all operating conditions during its mode of operation. A fuel supply tank for operation at full load for a minimum of 7 days will commonly supply fuel to the individual day tanks for each DGU.

The ADGU building drainage system will control any lubricating or fuel oil spills.

1.3 Diesel Engine Cooling Water System

Each diesel engine has a cooling water system capable of removing waste heat from the diesel engine block, lubrication oil system, turbocharger, and other components specified by the DGU manufacturer.

The main heat exchanger is the sole interface between the engine water-cooled systems and the ERCW. A three-way, thermostatic control valve provides for heat exchanger bypass to allow fast engine warmup.

1.4 Cooling Water System

All four ERCW headers (1A, 1B, 2A, and 2B) are routed to the ADGU heat exchanger. Headers 1A or 1B will be primary supplies, while 2A or 2B will be backup supplies. One primary and one backup supply will be automatically aligned as previously discussed when the ADGU is activated. The headers used will be the same as those normally supplying the DG being replaced. The motor-operated valves (MOVs) on the ERCW headers will be powered from the 480V diesel auxiliary board within the ADGU building.

1.5 Starting System

The unit has two complete, independent, pneumatic starting systems (one per each engine) which are equivalent to those described in the FSAR, section 8.3.

Each set of accumulators is of sufficient size to allow the unit to be started five times without recharging and without ac power available. One set of accumulators serves as a standby for the other. Two 480V ac motor-driven air compressors are supplied for this generator unit. A dual tower dessicant type air dryer is installed on each compressor discharge.

1.6 Diesel Engine Air Intake

The ADGU is equipped with a separate low-resistance oil bath air intake filter suitable for the environmental conditions encountered at the plant site. The filter is protected from airborne debris large enough to clog the filter air intake area. The intake piping was cleaned and coated with epoxy paint or an equivalent corrosion inhibitor to prevent rust from damaging turbochargers.

1.7 Diesel Engine Exhaust

Each diesel engine has a separate exhaust system capable of conveying engine exhaust gases out of the ADGU building any time the ADGU is running.

1.8 Generator

The generator operates at 6900V, 3-phase, and 60 Hz and produces a continuous rating of 4400 kW at 0.8 power factor. The generator is capable of being operated at 4840 kW for a period of 2 hours out of any 24 hours of operation. The generator is designed to operate over the same ambient temperature range as the diesels.

1.9 Exciter

The generator has a static-type excitation system that includes its voltage or current supply transformer, connections, bus exciter cubicle, voltage regulator, rectifiers, fuses, and all devices necessary to automatically control the generator during the loading cycle.

1.10 Generator Control Panel

The generator control panel is a free-standing floor-mounted panel complete with instrument and controls required for control. This panel monitors the same DG parameters as being monitored by the control panels on the existing DGs. This panel is located in the ADGU building.

1.11 Annunciation and Distribution Panels

The annunciation and distribution panel is a free-standing, floor-mounted panel which is the interface for interconnecting the instrument and controls from the disabled EDGU and the ADGU. The plug connectors used and control panels are class 1E qualified. See TVA drawing 45DS480, sheets 1 and 2, attached for specific locations.

1.12 Diesel Generator Control Power

The 125V dc ADGU's battery system is a class 1E system which has a function to provide control power for control and field flashing for the ADGU.

The 125V dc battery system consists of a battery charger (which supplies the normal steady-state dc loads and maintains the battery in a fully charged state and is capable of recharging the battery from the design minimum discharge of 105V dc while supplying the largest demand of the steady-state dc loads), a battery (for control and field flashing of the generator), and a distribution board (which facilitates the dc loads and provides circuit protection). The battery system is ungrounded and incorporates ground detection devices. The ADGU battery system is physically and electrically independent from the EDGU 125V dc battery systems and will be located on elevation 742.0 of the ADGU building.

The ADGU battery is of the lead-acid type and has 57 cells connected in series and divided into 19 units, every unit having three cells. The battery is a type 3DCU-9, furnished by the C&D Batteries Division of Eltra Corporation, rated at 22 ampere-hours at 40°F for a 30-minute discharge rate. With the battery in the fully charged condition, the battery has the capacity to supply 59 amperes (A) for one minute and 36 amperes for 30 minutes at 40°F and 80 percent of its rated capacity. The estimated design loads on the battery, during a loss of ac power, is 48 amperes (field flash) for two seconds and and 12 amperes (control) for 30 minutes. The battery is normally required to supply loads only during the time interval between loss of normal feed to its charger and the receipt of emergency power to the charger from the ADGU.

The normal supply of dc current to the battery board is from the battery charger. The charger maintains a floating voltage of approximately 128V on the associated battery board bus (the battery is continuously connected to this bus also) and is capable of maintaining 133V during an equalizing voltage. The charger supplies normal steady-state load demand on the battery board and maintains the battery in a charged state. Ac power for the charger is supplied from the 480V ac, 3-phase diesel auxiliary board C1-S. The charger is a solid-state type which converts a 3-phase 480V ac input to a nominal 125V dc output having a rated capacity of 20 amperes. Over this output current range the dc output voltage will vary no more than ± 1.0 percent for a supply voltage amplitude variation of ± 10 percent and frequency variation of ± 2.0 percent. Some operational features of the chargers are: (1) an output voltage adjustable over the range of 125V to 133V; (2) equalize and float modes of operation (the charger normally operates in the float mode at 128V, but can be switched to the equalize mode with an output of 133V; (3) a current-limit feature which limits continuous overload operation to 125 percent of rated output, (4) protective devices which prevent a failed charger from external overloads, and (5) metering and alarm circuits to monitor the charger output.

The ADGU 125V dc control and field flash circuits are supplied power from the ADGU 125V dc distribution panel located in the ADGU building on elevation 742.0. Each circuit (including the battery charger input to the panel) is protected by a thermal-magnetic circuit breaker. The battery input circuit to the panel is protected by a thermal-magnetic circuit breaker and a coordinated fuse. Local metering on the distribution panel and battery charger includes charger current, battery and charger voltage, battery system ground detection and battery charger and discharge current. Low battery charger output voltage, loss of 480V ac supply to the charger, battery-bus overvoltage, battery ground, battery discharge current, and battery main breaker trip or blown fuse, is alarmed in the MCR when the ADGU is substituted for an EDGU. For each load breaker, breaker open is monitored by loss of voltage alarms in each control circuit.

1.13 6.9-kV and 480V Board Configuration

The key diagram is shown on TVA drawing 15E500, sheets 1 and 2, attached. The ADGU will be connected to the 6.9-kV DG board C-S (sheet 2 of TVA drawing 45W728) through a normally closed breaker.

Compartments E-F-H-J of the board feed the EDGU's transfer switches. Only one breaker is used for these four compartments, thus only allowing the ADGU to be connected to one transfer switch at any one time when it is being substituted for an EDGU. The ADGU auxiliaries are supplied from the 480V diesel auxiliary board which is connected to compartment C of the 6.9-kV DG board C-S. The 480V board has two buses separated by a bus tie breaker. Bus B, which has a normally closed supply breaker (NSB) and is supplied power from the 6.9-kV common board A, feeds 480V diesel auxiliary board C2-S. Bus A of 480V diesel auxiliary board (C2-3) supplies the class 1E loads required to support ADGU when it is used as an onsite source. The bus tie breaker (TB) is normally closed except when the ADGU is operating as an onsite power source. When the DG has attained rated speed and voltage, the bus tie breaker is tripped and the Bus B supply breaker (DSB) is closed. Thus, the DG will supply the power for the class 1E loads only. Board C2-S Bus B remains connected to 6900V common board A only. The tie breaker cannot be manually reclosed unless the offsite supply incoming breaker (NSB) to Bus B is opened. The loads and board layouts are shown in drawings attached as discussed in section 1.1.7.

1.14 Aligning the ADGU for Service

Should any one of the four trained EDGUs become inoperable for longer than 72 hours or be expected to be inoperable over 72 hours, manual alignment of the ADGU will be necessary. The manual alignment sequence is as follows:

1.14.1 Water Supply

If the ADGU is replacing either train A EDGU, the normally closed manual valves in ERCW supply headers 1A and 2B are opened to provide primary and backup cooling, respectively. If a train B EDGU is being replaced, the valves in ERCW headers 1B and 2A are opened instead. The valves to the DG being replaced will be closed.

1.14.2 Control and Annunciation Cables

The control and annunciation cables are unplugged from the disabled EDGU's normal connectors on the annunciation and control distribution panel. In the ADGU building, the ADGU's control and annunciation cables are connected to the disabled DGU train annunciation and control distribution panel. When the connections are correctly made it is annunciated in the MCR. The connectors are keyed to assure that each plug can only be plugged into the correct receptable.

1.14.4 Disconnect and Transfer

The disabled EDGU 6.9-kV disconnect switch is opened and then the transfer switch to the ADGU is closed. The disconnect and transfer switches are class 1E qualified.

1.14.4 Feeder Breaker

The 6.9-kV feeder breaker is racked into the compartment of 6.9-kV DG board C-S for the disabled EDGU and closed.

1.14.5 Summary

Once the ADGU has been manually aligned to replace an EDGU, it can be controlled by the controls of the EDGU being replaced in the MCR. Annunciation is provided in the MCR to indicate which EDGU has been replaced by the ADGU. Panels located in the ADGU building contain all of the controls necessary to permit operation and testing of the ADGU locally. Once the ADGU has replaced an EDGU, the MCR controls permit local, remote manual, and remote automatic starting or stopping of the ADGU. The ADGU has the capability of being automatically transferred from manual to automatic control and will be ready to accept load within 10 seconds after receiving a start signal.

1.15 Environmental Design

The ADGU and auxiliary support systems are designed to operate in an individual building isolated from other plant structures. Environmental conditions that the ADGU installed in this manner must withstand without impairment are as follows.

1.15.1 Tornado Design

The ADGU is designed for the design basis tornado including the effects of external depressurization and missiles; consequently, all equipment necessary for the operation of the ADGU is designed to remain operable during and after this depressurization.

The ADGU equipment is protected from credible tornado missiles.

1.15.2 Earthquake Design

The ADGU, auxiliary support systems, and structure are designed to withstand and remain operable for the OBE and SSE. See also Appendix A, Section 3.0.

1.15.3 Probable Maximum Flood

The ADGU is capable of supplying power to operable equipment (required for safe shutdown) in the event that a maximum probable flood occurs. Wind wave was included where applicable.

1.15.4 Temperature and Ventilation

Inlet air temperature variations assumed in the heating and ventilation system (reference 3.1.3 for applicable design criteria) include extremes of high and low outdoor temperatures. The electrical board room and switchgear room temperature range will be from 40°F to 104°F. The heating and ventilation system will maintain an environment as recommended by the manufacturer of the ADGU and auxiliary equipment. Ventilation in the battery area will maintain hydrogen concentration below 2 percent volume. The fuel oil handling areas ventilation system will comply with NFPA 30.

1.16 Analysis ADGU AC Auxiliary Power System

The ADGU ac auxiliary power system is designed to comply with requirements set forth in GDC 2, 4, 5, 17, and 18. Also the design conforms with Regulatory Guides 1.6, 1.9, 1.32, 1.81, 1.108, and 1.118, NUREG/CR 0660 and IEEE Standards 387-1977, 308-1971, and 338-1971, with exceptions as noted herein. The design also meets the intent of IEEE 384-1974 and Regulatory Guide 1.75. The following paragraphs discuss each of these requirements:

1.16.1 General Design Criterion 2 and 4

The system and components of the ADGU are designed to be capable of withstanding the effects of natural phenomena, missiles and environmental conditions associated with normal operation and postulated accidents as established in Chapter 3 of the FSAR.

1.16.2 General Design Criterion 5

Regulatory Guide 1.81 describes an acceptable method of satisfying GDC 5 requirements for shared shutdown electric systems. The applicable NRC positions delineated in Regulatory Guide 1.81 are positions C.2.b, c, d, e, and f. When the ADGU is operating it is not shared between nuclear power units. Therefore, there will be no interaction between the ADGU ac auxiliary power system and the other EDGUs. This satisfies position C.2.d and makes the requirement of position C.2.f unnecessary. Unit operator coordination is not required, although the status of the DG is available in the common area of the MCR. This satisfies position C.2.e. Substitution of the ADGU will maintain adequate onsite power capacity without introducing safety hazards and therefore meets the position C.2.b and C.2.c requirements. Based on this information, the ADGU complies with GDC 5.

1.16.3 General Design Criterion 17

When the ADGU is substituted for one of the EDGUs, the onsite ac electrical power sources (i.e., the DGUs) and the onsite electrical distribution system has sufficient independence, redundancy, and testability to perform their safety function assuming a single failure.

1.16.4 General Design Criterion 18, Regulatory Guide 1.118, and IEEE 338-1971

Electric power systems of the ADGU important to safety are designed to permit appropriate periodic inspection and testing of important areas and features. In particular, the systems are designed with capability for periodic testing of the operability and functional performance of the components of the systems, such as onsite power sources, relays, switches, and buses, and also, the operability of the systems as a whole. In addition, under conditions as close to design as practical, the full operational sequence that brings the systems into operation will be tested periodically including applicable portions of the protection system, and the transfer of power among the nuclear power unit, the offsite power system, and the onsite power system.

The distribution system is monitored to the extent that it is shown to be ready to perform its intended function.

Status indicators are provided to monitor the standby power supply continuously. Annunciators are provided in the control room to monitor and alarm the status of the standby power supply.

1.16.5 Regulatory Guide 1.6

The only requirements of this guide which apply to the ADGU design is position D.2 and D.4a. The design of the ADGU is as a direct replacement for an EDGU and cannot be paralleled with the standby source of another load group under accident conditions.

1.16.6 Regulatory Guide 1.9 and IEEE 387-1977

The ADGU design conforms to all applicable positions with the exception of the following:

C.8 - Although a first-out surveillance system is not installed at WBN, all DG protective trips such as differential overcurrent have been provided with targets to indicate which protective device operated. In addition, the status of protective devices installed to shut down the DGU unit for generator or engine trouble are alarmed in the MCR. Where more than one protective device target is operated, an analysis of the problem will be done to determine which device operated first.

1.16.7 Regulatory Guide 1.32 and IEEE 308-1971

The applicable positions of Regulatory Guide 1.32 are C.1.d, e, and f. These positions require the use of Regulatory Guides 1.6, 1.75, and 1.9. Discussion of these guides is contained in other parts of this section. Sections 5.2.4 and 5.2.5 of IEEE 308-1971 apply to the ADGU. This standard criteria's requirements for function capability, availability, surveillance (see section 1.14), energy storage (see section 1.2), controls (see section 1.14), and control testing are met.

1.16.8 Regulatory Guide 1.108

See also our response to Regulatory Guide 1.9 for position C.1(5) compliance. The positions in this guide will be met except for position C.2.0.(2). Justification for this exception is as follows.

We understand this requirement to mean that the emergency loads be sequenced on to the DGU with each load operating at its full flow. This will be done as part of the Preoperational Testing Program (PREOPS). For subsequent periodic testing done after PREOPS, the loads will be sequenced on as designed except the pumps will be operated with their miniflow connection open and not at full flow.

1.16.9 Regulatory Guide 1.75 and IEEE 384-1974

The ADGU complies with Regulatory Guide 1.75 and IEEE 384-1974 through implementation of design criteria in reference 3.1.2. However, the Trains A and B cable trays in the conduit entry room of the EDGU building (TVA drawing 15W810, sheets 1 and 2, attached), and the ADGU building (TVA drawing 15W818, sheets 1 through 5, attached), are not separated by the minimum horizontal distance or by barriers. It is not necessary for these trays to be separated by the minimum distance since no more than one train will be operational at any given time. During normal operations, the four cable sets (one set per each two for Train B) routed through trays A or B, respectively, will not be energized nor electrically connected at either end (TVA drawings 45W727, 45W728, sheets 1 and 2, and 45W733, sheets 3 through 7, attached). The only time any of the four cable sets can be energized is after the ADGU has been manually aligned to replace an EDGU. During this time only, one of the four cable sets (Train A or B) can be energized, due to the fact that it is physically impossible to connect more than one of the four cable sets simultaneously. If a single event destroyed all the trays in the subject areas during normal operation or during the time the ADGU has replaced one of the EDGUs, the ADGU is the only unit that could be affected. Therefore, the plant could be brought to safe shutdown with the three remaining EDGUs.

1.16.10 NUREG/CR 0660

NUREG/CR 0660 has been reviewed previously for WBN (see response to FSAR questions 40.74-40.76, 40.79-40.111, and 40.127-40.128). The revised procedures and equipment modifications to improve DG performance on the first four EDGUs have been incorporated into the ADGU.

1.17 Analysis - ADGU 125V DC Control Power System

The ADGU 125V dc control power system is designed to comply with the requirements set forth in GDC 2, 4, 5, 17, and 18. Also, the design conforms with Regulatory Guide 1.6, 1.32, 1.81, 1.118, and 1.129, and IEEE Standards 308-1971, 338-1971, and 450-1975 with exceptions noted herein. The design also meets the intent of IEEE 384-1974 and Regulatory Guide 1.75.

The following paragraphs discuss each of these requirements.

1.17.1 General Design Criteria 2 and 4

The systems and components of the ADGU control power system are capable of withstanding the effects of natural phenomena, missiles, and environmental conditions associated with normal operation and postulated accidents as established in Chapter 3 of the FSAR.

1.17.2 General Design Criteria 5

The ADGU control power system is physically and electrically independent from the EDGU 125V dc control power system. Therefore, upon substitution of the ADGU with one of the EDGU, the structures, systems, and components required for safe operation at the ADGU control power system will not be shared with the EDGU battery systems.

1.17.3 General Design Criteria 17

This criteria will be applicable upon substitution of the ADGU for one of the EDGUs. At this time, the DG 125V dc control power system has sufficient independence (physically and electrically), redundancy, and testability to perform its intended safety function assuming a single failure.

1.17.4 General Design Criteria 18, Regulatory Guide 1.118, and IEEE 338-1971

The ADGU 125V dc battery system is designed to permit appropriate periodic inspection and testing of important areas and features, in order to assess the continuity of the system and the condition of its components. In addition, prior to placing the system into service, it will be preoperationally tested and thereafter periodically tested per the site surveillance program to ensure the proper operation of all components. Also, under conditions as close to design as practical, the full operational sequence that requires the battery system's operation will be tested periodically as a part of the DG periodic system test.

1.17.5 Regulatory Guide 1.32

The ADGU 125V dc battery system's charger has the capacity to continuously supply all steady-state loads and maintain the battery in the design maximum charged state or to fully recharge the battery from the design minimum discharge state within an acceptable time interval, irrespective of the status of the plant during which these demands occur. In addition, a capacity test will be performed periodically on the ADGU battery system, as recommended by IEEE 450-1975.

1.17.6 Regulatory Guide 1.6

The ADGU battery system will supply power only to the loads of the ADGU. Therefore, upon substitution of the ADGU, the plant DG battery system's safety loads are separated into redundant load groups such that loss of any one group will not prevent the minimum safety functions from being performed. Also, there are no provisions for manually or automatically interconnecting the redundant load groups of this system.

1.17.7 Regulatory Guide 1.81

Position C1: As stated previously, the ADGU control power system will supply power only to the loads of the ADGU. Therefore, this position does not apply.

1.17.8 Regulatory Guide 1.129 and IEEE 450-1975

The ADGU battery system will be maintained, and replaced (when required) under the guidelines set forth in the above documents. Testing shall be per Technical Specification 4.8.1.1.3.

1.17.9 IEEE 308-1971

As discussed in the above paragraphs, the overall system design of the ADGU 125V dc control power system incorporates appropriate function requirements, capability, and surveillance in order to comply with this criteria. In addition, the system design is such that the battery is immediately available during normal operations and following loss of power from the alternating-current system. Also, the system's battery has sufficient capacity to meet the power demand and time requirement of each connected load.

1.17.10 Regulatory Guide 1.75 and IEEE 384-1974

See degree of compliance as stated in Section 1.16.9.

1.18 Fire Protection

The ADG systems and building are designed to meet applicable fire protection criteria, including General Design Criteria 3, Branch Technical Position CMEB 9.5-1, 10 CFR 50 Appendix R, and NFPA 30. Exceptions or deviations to the literal requirements in Appendix R are only those which have been approved by NRC before unit 1 fuel loading.

2.0 TESTS (ADGU)

2.1 Shop Test

The power package was completely assembled and shop tested together with its subsystems before delivery. The test program covered the following items.

a. Verification that all components are correctly installed and interconnected.
b. Verification that each subsystem is complete and functions according to design criteria.
c. Individual tests of each protective device and verification of the accuracy of instrumentation set points.
d. Operation of the unit from 0 to 100 percent load starting at no load and increasing in increments of 33-1/3 percent with checks at each load point for stable operation, fuel consumption, engine performance, and generator performance.
e. Performance of full load transient test verifying that voltage and frequency transient characteristics are within the requirements of specification.
f. Operation of the unit for a period of 72 hours at its continuous rating.

g. In addition to the above and before delivery, the unit was set up ready to operate and tested for reliability of starting. The starting signal was activated and the unit demonstrated acceptability by engine starting and obtaining operating speed within a 10-second period. This test was repeated 25 consecutive times without failure.

2.2 Field Test

Field testing of the unit, auxiliary equipment, and associated systems will be scoped in TVA's Preoperational Testing Program, and comply with Regulatory Guide 1.108 (reference 3.2.13).

Prior to placing the 125V ac DG battery system into service, the system components will be tested to ensure their proper operation. The DG battery will be preoperationally tested for the following conditions:

1. To verify that the DG battery capacity will meet the manufacturer's guaranteed performance.

2. To verify that the DG battery system has the ability to supply power before, during, and after loss of the 480V ac power supply to the DG battery charger in the worst case condition.

3. To verify that the battery charger will recharge the DG battery from the design minimum charge state to the nominal charged condition regardless of the plant status.

3.0 REFERENCES

3.1 TVA Documents

3.1.1 WBN Nuclear Plant FSAR, Chapters 3 and 8, TVA, Knoxville, Tennessee.

3.1.2 Separation of Electric Equipment and Wiring, Design Criteria, WB-DC-30-4 (issued April 23, 1981), TVA Electrical Engineering Branch, Knoxville, Tennessee.

3.1.3 Additional Diesel Generator Building Environmental Control System, WB-DC-40-28.2 issued March 25, 1981, TVA Nuclear Engineering Branch.

3.2 NRC Regulations, Criteria, and Guides

3.2.1 10 CFR 50, Appendix A, "General Design Criteria for Nuclear Power Plants (GDC)"

GDC 2, "Design Bases for Protection Against Natural Phenomena";

GDC 3, "Fire Protection For Nuclear Power Plants";

GDC 4, "Environmental and Missile Design Bases";

GDC 5, "Sharing of Structures, Systems, and Components";

GDC 17, "Electric Power Systems"; and

GDC 18, "Inspection and Testing of Electrical Power Systems."

3.2.2 10 CFR 50, Appendix B, "Quality Assurance Criteria For Nuclear Power Plants and Fuel Processing Plants,"

3.2.3 10 CFR 50, Appendix R, "Fire Protection Program For Nuclear Power Facilities Operating Prior To January 1, 1979."

3.2.4 Branch Technical Position CMEB 9.5-1, "Guidelines For Fire Protection For Nuclear Power Plants."

3.2.5 NUREG/CR 0660, "Enhancement of Onsite Emergency Diesel Generator Reliability."

3.2.6 Regulatory Guide 1.6, "Independence Between Redundant Standby (onsite) Power Sources and Between Their Distribution Systems."

3.2.7 Regulatory Guide 1.9, Revision 2, "Selection of Diesel Generator Set Capacity for Standby Power Supplies," Nuclear Regulatory Commission; Washington, March 1971.

3.2.8 Regulatory Guide 1.32, "Use of IEEE Standard 308, Criteria for Class 1E Power Systems for Nuclear power Generating Stations."

3.2.9 Regulatory Guide 1.75, "Physical Independence of Electric Systems."

3.2.10 Regulatory Guide 1.81, "Shared Emergency and Shutdown Electric Systems for Multi-Unit Nuclear Power Plants."

3.2.11 Regulatory Guide 1.108, Revision 1 - "Periodic Testing and Diesel Generators Used as Onsite Electrical Power Systems at Nuclear Power Plants, U. S. Regulatory Commission, August 1977.

3.2.12 Regulatory Guide 1.118, "Periodic Testing of Electric Power and Protection Systems."

3.2.13 Regulatory Guide 1.129, "Maintenance, Testing, and Replacement of Large Load Storage Batteries for Nuclear Power Plants."

3.3 Codes and Standards

3.3.1 IEEE Standard 308-1971, "IEEE Standard Criteria for Class IE Power Systems for Nuclear Power Generating Stations."

3.3.2 IEEE Standard 323-1971, "IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations."

3.3.3 IEEE Standard 338-1971, "IEEE Standard Criteria for Periodic Testing of Nuclear Power Generating Station Protection System."

3.3.4 IEEE Standard 384-1974, "IEEE Standard Criteria for Independence of Class 1E Equipment and Circuits."

3.3.5 IEEE Standard 387-1977, "IEEE Standard for Diesel Generator Units Applied as Standby Power Supplies for Nuclear Power Generator Stations."

3.3.6 IEEE Standard 450-1975, "IEEE Standard for Recommended Practice Maintenance, Testing, and Replacement for Large Lead Storage Batteries for Generating Stations and Substations."

3.3.7 National Fire Protection Association (NFPA) Code 30

APPENDIX C

TENNESSEE VALLEY AUTHORITY
WATTS BAR NUCLEAR PLANT UNITS 1 AND 2

DESCRIPTION OF THE PREOPERATIONAL TESTING PROGRAM
FOR THE ADDITIONAL DIESEL GENERATOR UNIT

APPENDIX C
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DESCRIPTION OF THE PREOPERATIONAL TESTING PROGRAM

For the additional diesel generator unit, TVA will demonstrate the adequacy of the ADGU design by performing a series of preoperational tests. The test program will first verify the adequacy of the support subsystems required for ADGU operation. Then the onsite power system will be functionally tested in accordance with our commitments to the Regulatory Guides in section 1.0. The tests to be performed are briefly described in 2.0 through 9.0.

1.0 Regulatory Guides Applicable to Preoperational Testing

A. Regulatory Guide 1.108, revision 1
B. Regulatory Guide 1.9, revision 2
C. Regulatory Guide 1.41, revision 0
D. Regulatory Guide 1.68, revision 0
E. IEEE Standard 387-1977

2.0 TVA-73

This test will verify proper response of the following ADGU components and subsystems as well as the ADGU itself.

2.1 Remote Control and Annunciation Circuits Tests

Remote control and annunciation circuits shall be verified with the ADGU connected as a replacement for each of the EDGU. Remote control and annunciation circuits shall be verified with the EDGUs connected in their original positions.

2.2 Diesel Generator Blackout Tests

This test will demonstrate that the ADGU will start and attain rated voltage and frequency within acceptable time limits with a simulated blackout as the initiating event. This test will be performed with the ADGU connected as a replacement for each DG and rerun with each of the EDGUs in their original positions. The test will be acceptable if each DG starts and attains rated voltage and frequency and connects to the shutdown board in 10 seconds after the receipt of a bona fide start signal. At least one of the tests must be performed with the ADGU at operating temperature.

2.3 24-Hour Load Test and Design Accident Sequence

The following tests shall be completed in the order and for the required times specified herein.

2.3.1 The ADGU shall be manually started paralleled to the TVA grid and loaded to its continuous rating of 4400 kW. This load is to be maintained on the DG until the engine temperature reaches equilibrium. At this time, the load shall be increased to the DG's short-time rating of 4840 kW and run at this loading for two hours. Immediately following this two-hour period, the loading shall be reduced to the

DG's continuous rating of 4400 kW and run for 22 hours. The voltage and frequency shall be within 10 percent and 2 percent of their respective nominal value during the entire 24-hour plus test. The engine temperatures must be within ± 10°F of the normal operating temperatures established by the manufacturer.

The following data shall be recorded:
Generator frequency
Generator volts A-B, B-C, C-A
Generator amps A, B, C
Generator 3-phase kW
Generator 3-phase kilovoltamperes
Jacket water and lube oil temperatures

The 24-hour load test shall be considered acceptable if the ADGU is capable of supplying the indicated loads without exceeding the manufacturer's design limits.

2.3.2 Immediately after the 24-hour load test, the following testing must be accomplished.

With the ADGU connected to the heaviest (in terms of net change in real power with respect to time and total kW) loaded 6.9-kV shutdown board, the ADGU shall be started by creating a station blackout. Immediately after the station blackout, a safety injection (SI) signal shall be initiated. To obtain the worst case SI loading, the following sequence shall be used:

A. The miscellaneous 480V load that is energized at T=0 shall be comprised of:

   1. All 480V loads that may be given a permissive to run by some process: flow, pressure, temperature, etc.

   2. All 480V loads actuated by an SI signal or containment isolation phase "A" signal that are not sequenced on the DG sometime later.

   3. All 480V loads that would normally be tripped by a containment isolation phase "B" signal. (A containment isolation phase "B" signal should not be initiated at T=0 secs).

B. From 2 seconds to 2 minutes, the loading sequence shall continue as designed.

C. At 2 minutes, the containment spray pump shall be started without actuating the containment isolation phase "b" signal.

D. After 2 minutes, the loading sequence shall continue as designed with the ADGU supplying its sequenced load for 1 hour.

For this test the safety-related pumps must be aligned for full flow conditions. During the load sequence testing, the following limits shall be met or exceeded.

A. During the loading sequence, the frequency and voltage shall not be less than 95 percent of nominal and 75 percent of nominal, respectively.

B. During recovery from transients caused by step load increases or resulting from disconnection of the largest single load or complete loss of load, the DG set speed shall not exceed 115 percent of nominal.

C. During the loading sequence, the voltage must be restored to within 10 percent of nominal and frequency within 2 percent of nominal in less than 60 percent of each load sequence time interval.

D. Upon receipt of a bona fide start signal, the ADGU shall start and attain rated voltage and frequency within 10 seconds. A bona fide start signal is defined as the dropout of relays ES1AY, ES1BY, ES2AY, and ES2BY located in the associated EDGU protective relay panel.

For the above load sequence testing, the following information must be obtained:

A. Verification that the class 1E pumps sequenced on the DG are operating at full flow and pressure.

B. On each of the 6.9-kV shutdown boards, record the following from T=0 sec. to T=2.5 minutes.

   1. Bus voltage
      a. RMS - 1 phase (Ø-Ø)
      b. peak to peak - 2 phases

   2. Load current
      a. peak to peak - 2 phases
   3. Kilowatts - 3 phases

C. Record the frequency at the supply side of the emergency feeder breaker to the shutdown boards.

The test will be acceptable if the design limits are met or exeeded and the required data is recorded.

2.4 Diesel Generator Load Shedding

For the ADGU, this test requires load shedding of the largest single load connected to the generator and shedding of the full load. The test will be acceptable if the speed does not exceed 75 percent of the difference between nominal speed and the overspeed trip set point or 115 percent of nominal, whichever is lower.

2.5 Diesel Generator Start and Load Test

Twenty-three start and load tests are to be performed on the ADGU. The DG set is to be started and manually paralleled with the system loaded to at least 50 percent of its rated continuous capacity (2200 kW) and run in continuous operation for at least one hour. The test will be considered acceptable if the DG completes the required 23 consecutive start and load tests without a failure. The DG voltage, frequency, current output, lube oil outlet temperature, and jacket water outlet temperature shall be recorded and compared with data taken at the factory where applicable. Each start shall be initiated with the engines at standby temperatures.

2.6 Sychronizing with Offsite Power

This test will demonstrate the ability to (a) synchronize the DG with offsite power while the unit is connected to the emergency load, (b) transfer the load to offsite power, (c) isolate the DG unit, and (d) restore to a standby status. This shall be accomplished immediately after the load sequence testing.

2.7 Blackout with Diesel Generator in the Test Mode

The DG will be connected in parallel with offsite power and a simulated overcurrent on Device 50 will be used to verify that the emergency feeder breaker will trip on overcurrent while in the test mode only.

2.8 Testing of Redundant Diesel Generator Units

The following testing shall be performed with ADGU connected as a replacement for each of the trained DGs and rerun with each of the trained DGs in their original positions.

This testing is to verify that for an accident signal in the absence of a sustained loss of voltage, all four DGs will start, but not automatically connect to their respective shutdown boards. The test shall be considered satisfactory if the above conditions are met.

2.9 Independence of Redundant Onsite AC Power Sources

This test is to be performed concurrently with the DG blackout test. This test will be considered acceptable if while performing the DG blackout test all other onsite ac power sources not under test are disconnected and an absence of voltage is verified at the other onsite buses. During this test, the voltage at all onsite buses shall be recorded.

2.10 Diesel Generator Margin Qualification Test

Two margin qualification tests shall be performed on the ADGU set to demonstrate the capability to start and carry loads that are greater than the most severe step change within the plant design loading sequence.

The test shall be performed in the following manner:

A. An equivalent motor load of at least 1750 hp shall be started by the DG. It is not required to have a preload on the DG.

B. The DG voltage and frequency shall be recorded.

The test shall be considered acceptable if:

A. The DG can start and accelerate the above load without experiencing instability that results in generator voltage collapse.

B. There is not significant evidence of the inability of the generator voltage to recover.

C. There is sufficient engine torque available to prevent engine stall and allow the engine speed to recover.

After successful completion of this test, the DG set shall be inspected in accordance with the manufacturer's standard procedure and the inspection results shall be documented.

2.11 6.9-kV Diesel Generator Board

This testing is to verify that the input breaker to the 6.9-kV DG board will trip on a differential current. Verify proper tripping of the feeder breaker supply for the diesel auxiliary supply board.

2.12 480V Diesel Auxiliary Supply Board

This testing is to verify that the overcurrent protection and control interlocks in the breaker control circuits perform as designed.

2.13 480V Diesel Auxiliary Board Undervoltage

This testing is to verify undervoltage annunciation on diesel auxiliary boards C1-S and C2-S.

3.0 TVA-74A

This test will verify that the DG fuel oil system can transfer oil from the unloading station to the yard or DG building storage tanks. The system will also enable transfer between different DG fuel oil tanks. The test will probe the system's ability to transfer fuel oil in all operational modes and verify the proper functioning of the associated controls, annunciators and interlocks.

The portion of the fuel oil system from the day tanks to the fuel oil injectors will be verified by successful completion of the integrated test, TVA-74E. The following systems, subsystems, and components will be tested to verify acceptable performance.

3.1 Yard Transfer Pump

The yard transfer pump will be used to transfer fuel oil from either storage tank to the ADGU 7-day storage tank and to reject oil from this tank through the reject connection. Annunciators for low level/high level on the ADGU 7-day tank will be tested by level manipulation.

3.2 ADGU Building Transfer Pump

The ADGU building transfer pump will demonstrate the capability to transfer fuel oil from the ADGU 7-day tank to any other 7-day tanks. Transfer capability from any 7-day tank to the ADGU tank will also be tested. This pump can also transfer oil from the 7-day tanks back to the yard storage tank.

3.3 Diesel Skid-Mounted, Motor-Driven Pumps

These pumps will be tested to demonstrate their capability to transfer fuel oil from the ADGU 7-day tank to the diesel engine day tanks 1C1 and 1C2. The automatic start and automatic shutoff will also be tested. At test initiation, the day tank levels will be below pump shutoff. The day tank high and low level alarms will be checked by tank level manipulation.

4.0 TVA-74B

This test verifies the proper functioning of the DG starting air system. The air compressors, receivers, motors, and dryers will be shown sufficient to meet the design criteria.

4.1 Starting Air System Compressor Control

The automatic start and stop features will be verified to show automatic control of receiver pressure with proper annunciator function.

4.2 Air Receiver and Air Start Motor

The alarms will be shown to operate correctly on low pressure and reset upon restoration of normal air receiver pressure. At the low pressure limit, the air receiver capacity will be shown sufficient for five start attempts.

4.3 Air Start Motor Cycle

The solenoid valves on the air receivers outlet will demonstrate acceptable cycling to attempt a DG start then cycle closed and remain closed until the next start attempt. An annunciator will alarm after the third cycle without a DG start.

4.4 Air Dryer

The effectiveness of the air dryers will be tested to show that the outlet air dewpoint is trending toward a dewpoint of -10°F.

5.0 TVA-74C

This test section will verify proper operation of the ADGU building heating and ventilation system. The starting of the ADGU will initiate opening of the intake and exhaust dampers, and starting of an exhaust fan. On high room temperature or low air flow, the second fan will start. On low temperature, the fans will stop, and the dampers will close. The capability to meet heat load rejection criteria will be verified.

6.0 TVA-74D

The adequacy of the 125V control and field flashing batteries for the ADGU will be verified. IEEE 450 will be used as a guide for testing. The capability of the associated battery chargers will be demonstrated. The ADGU controls, annunciators, and field flashing will be verified operable with the batteries providing control power. The time to recharge the control and field flashing batteries will be determined.

7.0 TVA-74E

This section will demonstrate that the interlock, logic, relay actuation actions, and indicating lights and alarms function as designed for: the engine controls and alarms, the DG exciter and regulator, the protective relays, the motor-driven fuel oil pump relays, the DG remote circuitry relays, and the preheat system.

The test will also verify that on a receipt of an emergency start signal, the DG will start, come up to rated speed and voltage, and close the diesel breaker to the shutdown board in 10 seconds.

8.0 TVA-74F

The operability of the fire protection system hose stations, sprinklers and detector system control and alarm functions will be verified. A minimum high pressure fire protection (HPFP) system pressure will be determined, and the capability to manually start a HPFP pump locally will be demonstrated.

9.0 TVA-18B, -18C, (unit 2)

The capability of the ERCW system will be shown by manually operating the ERCW supply valves to the ADGU heat exchangers both from the MCR and locally. Automatic opening will be verified on a DG start signal. The capability to provide sufficient ERCW flow will also be checked.