



U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
Air Traffic Organization Policy

ORDER
JO 6480.22

Effective Date:
09/18/2007

Subj: Maintenance of Dual Redundant Power Distribution Systems (DRPDS) Facilities

1. Purpose.

a. This handbook provides guidance, technical standards and tolerances, and procedures applicable to the maintenance and inspection of Terminal Radar Approach Control Facilities (TRACONS) utilizing Dual Redundant Power Distribution System (DRPDS) electrical distribution systems. It also provides information on special methods and techniques, which will enable maintenance personnel to achieve optimum performance from the equipment.

b. This information augments information available in instruction books and other handbooks, and complements the latest edition of Order 6000.15, General Maintenance Handbook for National Airspace Systems (NAS) Facilities.

2. Distribution.

a. This document is made available to sites with this Facility, Service, and Equipment Profile (FSEP): DRPDS, Potomac TRACON (PCT), Northern California TRACON (NCT), Atlanta TRACON (A80) and Honolulu Combined Facility (HCF).

b. For electronic copies, use the Technical Library website at <http://nas.amc.faa.gov>.

c. For printed copies, national offices distribute to sites with an accurate inventory record in FSEP and a mailing address in the Direct Distribution System (DDS)

d. For help in updating inaccurate FSEP and/or DDS records, visit our website at http://nas.amc.faa.gov/technical_library/template.jsp?bodyPage=help.html&title=Help.

3. Maintenance and Modification Procedure.

a. The Order 6000.15, this handbook, the applicable equipment instruction book, and other applicable handbooks shall be consulted and used together by the maintenance technician in all duties and activities for the maintenance of Dual Redundant Power Distribution System (DRPDS) facilities and equipment. The three documents shall be considered collectively as the single official source of maintenance policy and direction authorized by Operational Support. References located in the appropriate paragraphs of this handbook entitled Chapter 3, Standards and Tolerances, Chapter 4, Periodic Maintenance, and Chapter 5, Maintenance Procedures, shall indicate to the user whether this handbook and/or the equipment instruction book shall be consulted for a particular standard, key inspection element or performance parameter, performance check, maintenance task or maintenance procedure.

Distribution: 83DA

Initiated By: AJW-223

b. The latest edition of Order 6032.1, National Airspace System Modification Program, contains comprehensive direction concerning the development, authorization, implementation, and recording of modifications to facilities, systems, and equipment in commissioned status. It supersedes all instructions published in earlier editions of maintenance technical handbooks and related directives.

4. Forms Listing. In addition to forms required by Order 6000.15, an automated log is to be maintained at facilities that have remote maintenance monitoring capability.

a. Forms may be electronically downloaded from the FAA Electronic Forms Database located at <http://feds.faa.gov>.

b. A current Record of Changes is available at under the link for this order.

5. Recommendations for Improvement. Users are encouraged to submit recommendations for improvement to 9-Amc-AJW141TechDocServices@faa.gov.



Mary Golia
Director, Technical Operations ATC Facilities

Table of Contents

Chapter 1. General Information and Requirements

<i>Paragraph</i>	<i>Page</i>
100. Objective.....	1-1
101. Scope	1-1
102. Revisions	1-1
103. Maintenance Procedures.....	1-1
104. Coordination of Maintenance Activities	1-1
105. Periodic Maintenance	1-1
106. Safety	1-2
107. Abbreviations and Symbols.....	1-2
108. Certification Requirements.....	1-6
109.-199. Reserved.	

Chapter 2. Technical Characteristics

200. Purpose or Function.....	2-1
-------------------------------	-----

Section 1. General Description

201. System Description.....	2-1
202. Commercial Power	2-9
203. Standby Power.....	2-9
204. Essential Power	2-15
205. Critical Power System	2-22
206. System Monitoring and Control	2-35
207. AC/DC Control and Interrogation Power.....	2-39

Section 2. System Operation

208. Operation on Commercial Power	2-41
209. Loss of 1M1 Commercial Feed at SWGR 1.....	2-43
210. Return of 1M1 Commercial Feed to SWGR 1	2-45
211. Loss of 2M1 Commercial Feed at SWGR 2.....	2-46
212. Return of 2M1 Commercial Feed at SWGR 2	2-48
213. Transfer to Standby Power	2-49
214. Operation on Standby Power.....	2-51
215. Return to Commercial Power	2-54
216. Loss and Restoration of Power at Critical Bus A.....	2-57
217. Loss and Restoration of Power at Critical Bus B.....	2-57
218. Loss and Restoration of CDP Power	2-57
219.-299. Reserved.	

Table of Contents (Continued)

<i>Paragraph</i>	<i>Page</i>
 Chapter 3. Standards and Tolerances	
300. General	3-1
301. Commercial Power	3-2
302. Standby Power	3-2
303. Uninterruptible Power System (UPS)	3-14
304. Control and Interrogation Power Systems.....	3-22
305. Distribution Equipment	3-28
306. DRPDS Circuit Breaker Settings.....	3-31
307. Power Distribution Units (PDUs).....	3-31
* 308. L3 Solid State Automatic Transfer Switches (SATS).....	3-33
309. PMCS	3-34
310. Electrical Power Raceways	3-36 *
311. - 399. Reserved.	
 Chapter 4. Periodic Maintenance	
400. General	4-1
401. References	4-1
 Section 1. Performance Checks	
402. Every 2 Hours	4-3
403. Every 8 Hours	4-3
404. Daily	4-3
405. Weekly (Reserved).	
406. Monthly	4-3
407. Quarterly	4-3
408. Semiannually	4-4
409. Annually	4-5
410. Triennially	4-7
411. - 435. Reserved.	
 Section 2. Other Maintenance Tasks	
436. Weekly.....	4-9
437. Monthly	4-9
438. Quarterly (Reserved).	
439. Semiannually	4-10
440. Annually	4-10
441. Biennially	4-16
442. Every 3 Years	4-17
443. Every 5 Years	4-17
444. - 499. Reserved.	

Table of Contents (Continued)

Paragraph

Page

Chapter 5. Maintenance Procedures

500.	Purpose or Function.....	5-1
------	--------------------------	-----

Section 1. Performance Check Procedures

501.	General	5-1
502.	FAA Technical Performance Record (TPR) Entries	5-1
503.	2 Hour Performance Checks While Operating on Standby Power.....	5-1
504.	8 Hour Performance Checks While Operating on Standby Power.....	5-2
505.	8 Hour Performance Checks for DRPDS While Operating on Commercial Power	5-3
506.	Daily Fuel Filtration	5-5
507.	Commercial Power Transformer Preventive Maintenance	5-6
508.	UPS Monthly Performance Checks.....	5-7
509.	Engine Generator Monthly Performance Checks.....	5-7
510.	Transient Voltage Surge Suppressor (TVSS) Monthly Performance Checks.....	5-8
511.	Monthly Transfer Switch Operation for Control and Interrogation Power Systems.....	5-8
512.	PMCS Quarterly Performance Checks.....	5-9
513.	DC System Quarterly Performance Checks	5-10
514.	Semiannual Utility Outage Test	5-10
515.	Engine Generator 2 Hour Run and Step Load Test.....	5-12
516.	EG High Temperature Warning and Shutdown Test	5-13
517.	EG Low Oil Pressure Warning and Shutdown Test.....	5-13
518.	EG Low Fuel Level Warning Test	5-14
519.	EG Over-crank Test.....	5-15
520.	EG Low Coolant Level Shutdown Test.....	5-16
521.	EG Not-In-Auto Lamp Test.....	5-16
522.	EG Emergency Stop Test	5-17
523.	EG Over-Voltage Shutdown Test.....	5-17
524.	EG Under-Voltage Shutdown Test.....	5-19
525.	EG Under-Frequency Shutdown Test	5-20
526.	EG Over-Frequency Shutdown Test	5-21
527.	EG Low Battery Voltage Test	5-23
528.	EG High Battery Voltage Test	5-23
529.	Automatic Transfer Switch Test (UV) For Control and Interrogation Power Systems ..	5-24
*	530. Verify Proper STS Operation from the Front Display Panel	5-25
531.	Annual SATS Inspections	5-25
532.	Annual SATS Performance Checks using Powerlogic SMS-3000 software	5-26
533.	Annual SATS Performance Checks using a Line Disturbance Analyzer (LDA).....	5-30
534.	-550. Reserved.	

*

Table of Contents (Continued)

Paragraph *Page*

Section 2. Other Maintenance Tasks Procedures

551. – 575. Reserved.

Section 3. Special Maintenance Procedures

576. – 599. Reserved.

Appendix 1. Certification Requirements

*	A-1. System and Subsystem Certification	A1-1
	A-2. General	A1-1
	A-3. Certification Procedure.....	A1-2
	A-4. Line Disturbance Analyzer	A1-8
	A-5. Powerlogic Circuit Monitor (CM4000) Setup Procedure	A1-10 *

List Of Tables

Table *Page*

Chapter 2

2-1. SubStation Transformers	2-9
2-2. DRPDS EG Information.....	2-10

Appendix 1

*	A-1. DRPDS Power System	A1-12 *
---	-------------------------------	---------

List Of Illustrations

Figure *Page*

Chapter 2

2-1. DRPDS Systems Block Diagram	2-4
2-2. DRPDS Single-Line Diagram	2-5
2-3. UPS Block Diagram	2-26
2-4. PMCS Overview.....	2-37

*

Appendix 1

A-1. Dranetz Connection	A1-9 *
-------------------------------	--------

Chapter 1. General Information and Requirements

100. Objective. This handbook, in conjunction with information in instruction books and other handbooks, gives guidance for proper maintenance of selected Terminal Radar Approach Control Facility (TRACON) electrical systems.

101. Scope. This handbook gives the system-oriented information, not available in equipment instruction books and other handbooks, which ties together the units and components that make up the TRACON electrical system. Coverage applies to TRACON facilities at Northern California (CA), Atlanta (GA), Honolulu (HI), and Potomac (VA). The electrical system described herein specifically details a dual redundant power distribution system (DRPDS). The periodic maintenance and certification requirements contained in this handbook apply to the identified TRACONs where applicable. The information given herein covers the DRPDS, which includes the following subsystems:

- a. **Commercial Power.**
- b. **Standby Power.**
- c. **Critical Power.**
- d. **Essential Power.**

102. Revisions. All maintenance handbooks must be accurate and adequate to meet the requirements of field personnel. Users of this handbook should report any errors and submit suggestions for improvement to AJW-223, or can be e-mailed to 9-Amc-AJW141TechDocServices@faa.gov.

103. Maintenance Procedures. The procedures published herein pertain to maintenance of the system on an agency-wide basis. Other referenced maintenance handbooks, equipment instructions and locally established requirements pertaining to specific equipment installed at a particular site must govern equipment maintenance procedures.

104. Coordination of Maintenance Activities. Maintenance personnel responsible for maintaining TRACON DRPDS electrical system must conduct risk assessment and mitigation and must coordinate maintenance activities on TRACON DRPDS electrical systems with air traffic control (ATC) personnel at all times to preclude unanticipated interruption of services provided by the system. Maintenance personnel assigned to the TRACON are responsible for maintaining the equipment in an operational condition within the tolerances specified in chapter 3 of this handbook. Maintenance personnel must tell supervisory personnel immediately upon equipment failure, restoration to service, and whenever the established tolerances are exceeded or expect to be exceeded.

105. Periodic Maintenance. The periodic maintenance tasks and schedules provided in chapter 4 must be followed. Chapter 4 provides the minimum essential maintenance activities and the required frequency. Performance of periodic maintenance assures satisfaction of required performance standards.

106. Safety. Personnel must exercise care while working on electrical system equipment. Personnel must exercise particular caution when high voltages are present, when inspection plates and dust covers are removed, or when access doors are open exposing internal wiring. Personnel must never work alone on electrical equipment.

Warning

Contact with ac or dc potentials can result in severe shock, burns, or loss of life.

a. Personnel must apply lockout/tagout procedures in accordance with the latest edition of Order 3900.19B and Order 6000.15C prior to servicing or maintaining equipment. Personnel must take precautions to prevent activating the engine generators (EG) while conducting service or repairs. Personnel must follow the applicable safety and work practices contained in the latest edition of Orders 6000.15C and 3900.19B and pay particular attention to the specific warnings and cautions contained in this handbook and in the equipment instructions.

b. All individuals must be thoroughly familiar with general electrical system maintenance procedures and safety practices, prior to working on equipment, to not endanger themselves or others. Ignorance and carelessness are the predominant factors involved in most accidents. Personnel must pay particular attention to the proper use of the grounding cable prior to working on high-voltage circuits.

107. Abbreviations and Symbols. The following abbreviations and symbols appear in the text and illustrations contained in this handbook:

810D	Square D Trip Unit designator
A	Ampere
A80	Atlanta TRACON
ac	Alternating current
ACOV	AC over-voltage
ACUV	AC under-voltage
ALCAD	Original equipment manufacturer
ASCO	Original equipment manufacturer

AT	air traffic
ATC	Air Traffic Control
AVO	Original equipment manufacturer
BMA	Vendor Identifier for Powerware Battery Monitor
BMS	Battery Monitoring System
C	Celsius
CCP	Critical Control Panel
CDP	Critical distribution panel
CERAP	Combined Center Radar Approach Control
CK	Square D circuit breaker model
CM	Circuit Monitor
COTS	Components off the shelf
CPU	Central processing unit
dc	direct current
DCOV	DC over-voltage
DCUV	DC under-voltage
DD	Detroit Diesel
DDEC	Detroit Diesel Electronic Control System
DRPDS	dual redundant power distribution system
DS	Square D circuit breaker model
DVR	Digital voltage regulator
EEP	Electrically erasable programmable read only memory

EG	engine generator
F	Fahrenheit
FRDF	Facility reference data file
GUI	Graphical user interface
HCF	Honolulu Combined Facility
hr	Hour
HVAC	Heating ventilation and air-conditioning
Hz	Hertz
IAW	In accordance with
IGBT	Insulated gated bipolar transistor
I/O	Input/Output
ITPU	Inverse time pick-up
KA	Circuit breaker type
kV	Kilovolt
KVA	Kilovolt ampere
kW	Kilowatt
LB	Load bank
LBDP	Load bank distribution panel
LED	Light emitting diode
MA	Circuit breaker type
MCC	Motor Control Center
MCCABE	Molded Case Circuit Breaker

ME	Square D circuit breaker model
MPRO	Monitor Pro
mS	Milliseconds
MX	Circuit breaker type
na	not applicable
NAS	National Airspace System
NCT	Northern California TRACON
NEMA	National Electrical Manufacturers Assn.
NiCad	Nickel Cadmium
NiCd	Nickel Cadmium
NOP	Normal Operating Pressure
NOT	Normal Operating Temperature
NSJ	Square D/Merlin Gerin circuit breaker
OV	Over-voltage
OVS	Operator Work Station
PCT	Potomac Consolidated TRACON
PDI	Power Distribution Incorporated
PDU	Power distribution unit
PF	Power Factor
PLC	Programmable Logic Controller
PMCS	Power monitoring and control system
PS	Power Supply
PSG	paralleling switchgear

Psi	pounds per square inch
Psig	pounds per square inch gauge
QED	Square D SWBD style
Rpm	revolutions per minute
S	second (time)
SATS	Solid state automatic transfer switch
SCR	Silicon Controlled Rectifier
SLR/SLRF	Diversified Relay model #
SWBD	Switchboard
SWGR	Switchgear
THD	Total harmonic distortion
TI	Technical Instruction
TRACON	Terminal Radar Approach Control Facility
TVSS	Transient voltage surge suppression
UPS	Uninterruptible power system
UV	Under-voltage
V	Volt
VRLA	valve regulated lead acid
XHP	Battery model

108. Certification Requirements. Certification for the DRPDS is located in appendix 1 of this handbook.

109. – 199. Reserved.

Chapter 2. Technical Characteristics

200. Purpose or Function. The dual redundant power distribution system (DRPDS) supplies and distributes power to all Terminal Radar Approach Control Facility (TRACON) systems requiring electrical service. The system is designed to support critical and essential loads. Critical loads consist of electronic and computer equipment which directly support air traffic (AT) navigation. These loads cannot tolerate power outages or disturbances and therefore require uninterruptible-conditioned power. Essential loads consist of cooling towers, pumps, chillers, air compressors, fans, facility lighting, and general-purpose electrical outlets. Essential loads are no less important to the success of the facility mission but do not require continuous conditioned power. The DRPDS is designed to provide redundant uninterruptible-conditioned power to critical loads and redundant commercial or standby power to essential loads.

Section 1. General Description

201. System Description. The DRPDS is comprised of the subsystems and equipment shown in Figure 2-1, DRPDS System Block Diagram. The DRPDS receives power from two utility transformers, or parallel engine generators. The DRPDS distributes utility or engine power through redundant paths to essential and critical distribution areas. As the DRPDS Single-Line Diagram shows in figure 2-2, most of the DRPDS distribution areas (i.e., Switchgear (SWGR), Switchboards (SWBDs), Motor Control Center (MCCs) and Critical Distribution Panels (CDPs)) employ a main tie main configuration between two buses to power downstream loads.

a. Normally, the two buses receive power from their own main breaker. When power is not available at the main breaker or maintenance is required, the buses can be tied together with the tiebreaker to power downstream loads through a redundant path. The DRPDS delivers iso-redundant uninterrupted power supply (UPS) power through critical distribution areas. The critical distribution areas utilize a configuration of dual critical buses, power distribution units (PDUs) and solid state automatic transfer switch (SATS) to provide redundant paths to critical distribution panels.

b. The DRPDS breaker trip settings are coordinated using traditional time delayed selectivity. Main, and UPS SWGR breaker trip units are interconnected to communicate with each other in zone selective interlocks. In the zone selective interlock scheme, the breaker closest to the fault inhibits the upstream circuit breaker from tripping instantaneously while it clears the fault within the minimum time delay regardless of its time delay setting. If the breaker closest to the fault does not clear the fault, the upstream breaker will trip at the end of its time delay setting.

c. Normally, DRPDS breaker controls are set for remote operation. In remote operation, the DRPDS is controlled from the power monitoring and control system (PMCS). When the PMCS is not available, the DRPDS equipment can be operated locally to power TRACON loads. A brief functional description of each subsystem is provided in paragraphs 201a through 201p. A more detailed description of the DRPDS is provided in paragraphs 202 through 218 and the references identified in chapters 3 and 4 of this handbook.

- a. Commercial Transformers.** Utility services supply power to two commercial transformers. One transformer provides power to Main Switchgear 1 while the other provides power to Main Switchgear 2.
- b. EGs.** Four engine generators (EGs) provide standby power at Northern California TRACON (NCT), Potomac Consolidated TRACON (PCT), and Atlanta TRACON (A80). Three EGs provide standby power at Honolulu Consolidated Facility, (HCF). Each engine is normally controlled from the paralleling switchgear (PSG).
- c. PSG.** The Paralleling SWGR is responsible for starting, synchronizing, and paralleling EGs when main SWGR 1 and 2 require standby power. It is also capable of testing the EGs using the load bank.
- d. Main SWGR.** Main SWGR 1 and SWGR 2 receive and distribute commercial or standby power to downstream SWBDs, Motor Control Center (MCCs), UPS SWGR and emergency fire pumps.
- e. SWBD 1 and SWBD 2.** Switchboard (SWBD) 1 and SWBD 2 supply power to various essential loads including facility lighting equipment, general-purpose outlets, dc Control Power System, and EG battery chargers.
- f. MCCs.** MCCs provide power to various motor loads including the facilities heating, ventilation and air conditioning (HVAC) system.
- g. LB and LBDP.** The load bank (LB) provides a linear electrical load for sub-system testing. The load bank distribution panel (LBDP) provides load bank connections to the EGs and the UPSs (including the test UPS).
- h. UPS SWGR.** The UPS SWGR distributes power to the rectifier of UPS 2 and UPS 3 as well as the bypass of UPS 1. The UPS supply bus also provides a bypass connection to each critical bus in the event that the critical bus becomes de-energized or maintenance needs to be performed on an UPS.
- i. UPS.** UPS 1, UPS 2, and UPS 3 generate uninterruptible power for critical loads. UPS 2 and UPS 3 are connected to critical **A** and **B** buses, respectively. UPS 1 provides power to the bypass in UPS 2 and UPS 3. A test UPS is available for testing.
- j. UPS Output SWBDs.** The UPS Output SWBDs distribute UPS output power. Output SWBD #2 connects UPS 2 to Critical **A** bus or the load bank distribution panel. Output SWBD #3 connects UPS 3 to Critical **B** bus or the load bank distribution panel. SWBD #1 connects UPS 1 to UPS 2 and UPS 3 or the load bank distribution panel.

k. Critical Buses. Two critical buses, bus **A** and **B** distribute 480/277V ac (three wire) power to downstream power distribution units (PDUs).

l. PDUs. Eight (six for HCF) PDUs transform Critical **A** and **B** buses from 480/277V ac (three wire) to 208/120V ac (four wire). Each PDU feeds two static automatic transfer switches (SATS). The PDUs are configured in pairs to allow maintenance on one while the other powers the downstream SATS.

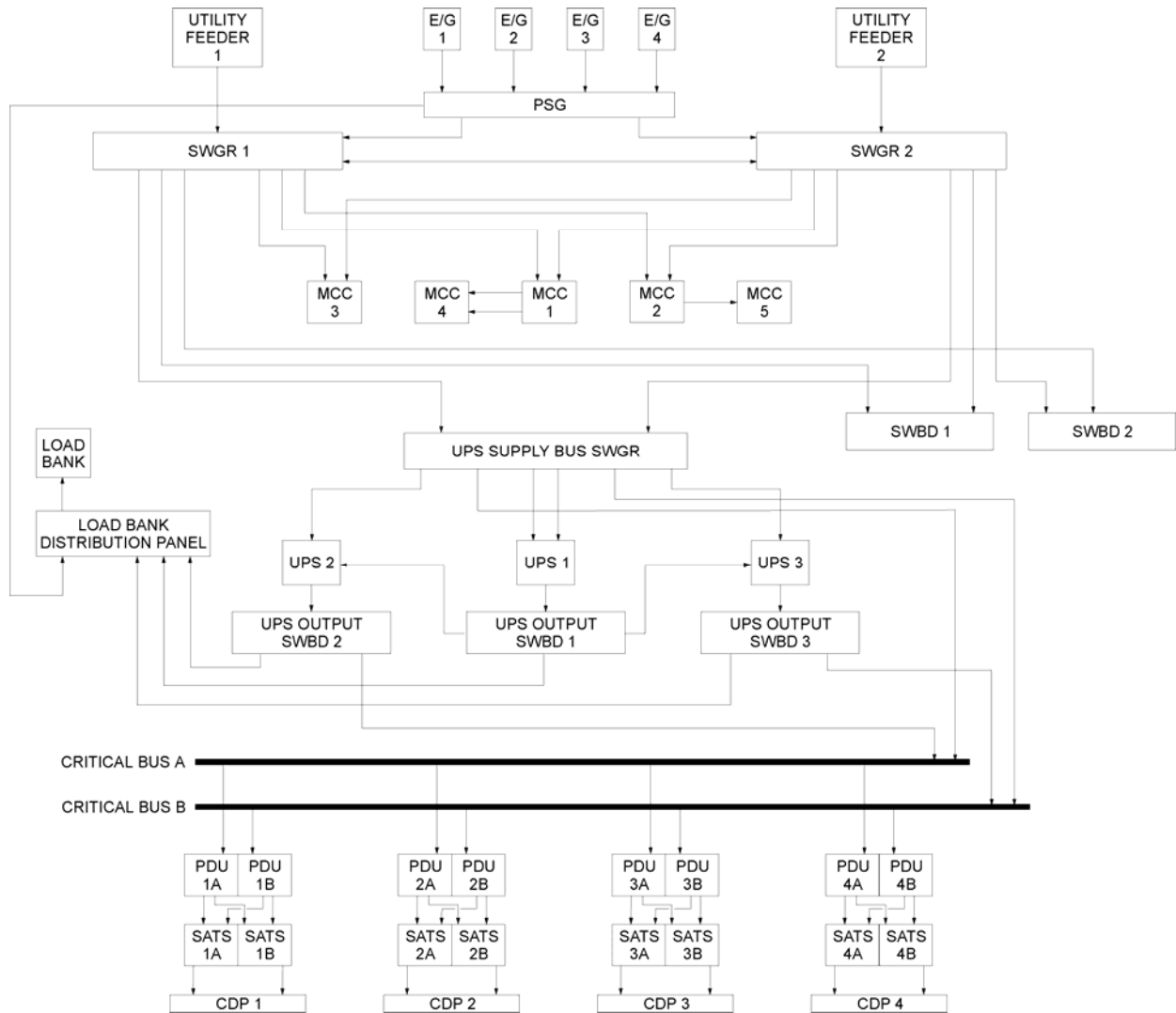
m. SATS. Each SATS receives two sources of critical power. Source 1 is powered by a PDU fed from critical bus **A** while Source 2 is powered by a PDU feed from critical bus **B**. When one source fails, the SATS will automatically switch to the other source. Each SATS output feeds one side of a CDP explained below.

n. CDPs. Four CDPs (three at HCF) distribute power from upstream SATS to downstream critical power panels. The CDP is a modified MCC design that allows isolating an upstream SATS for maintenance without impacting downstream critical loads.

o. PMCS. The PMCS interfaces with each DRPDS subsystem. The PMCS provides automatic control (without operator interaction) of the DRPDS, and allows Federal Aviation Administration (FAA) personnel to monitor and manually control the major functions of the DRPDS from a remote location.

p. AC interrogation and DC Control Power. The PMCS interfaces with ac interrogation and dc control power systems to interrogate and control DRPDS subsystem devices.

Figure 2-1. DRPDS Systems Block Diagram



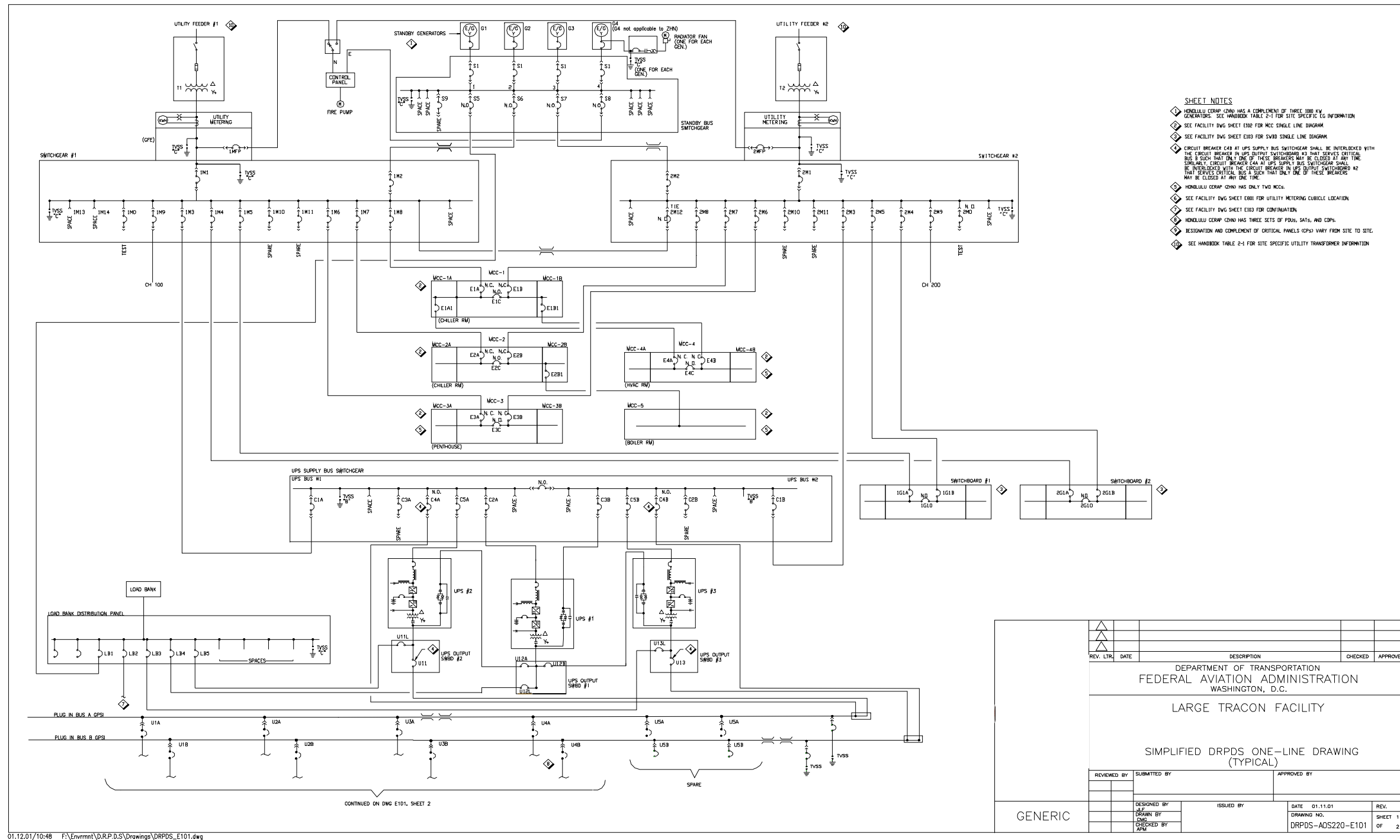
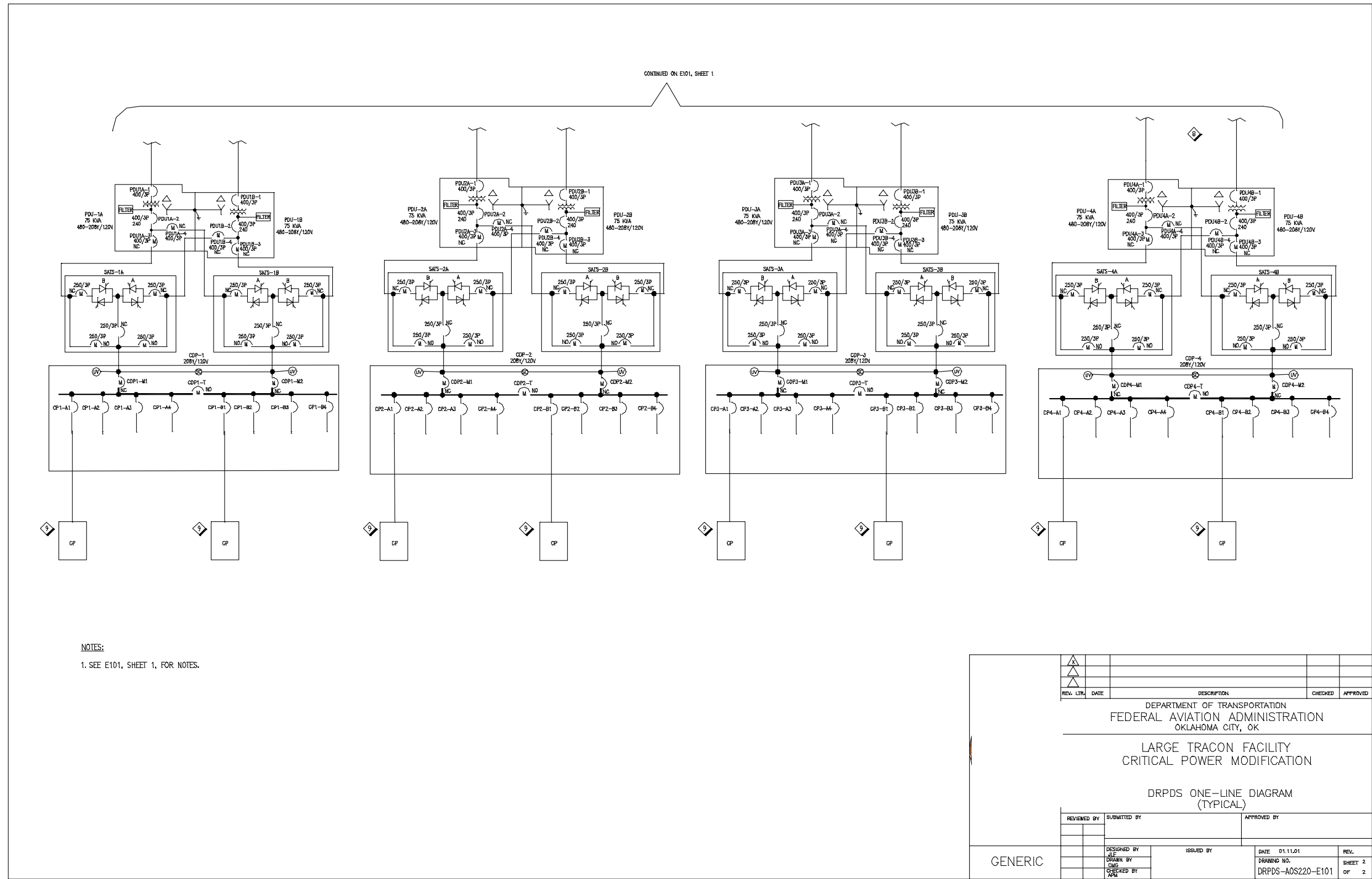


Figure 2-2. DRPDS Single-Line Diagram (Sheet 1 of 2)



01.12.01/11:31 F:\Environ\DRP.D.S\Drawings\DRPDS_E101A.dwg

Figure 2-2. DRPDS Single-Line Diagram (Sheet 2 of 2)

202. Commercial Power. Two incoming 3-phase high-voltage utility services supply commercial power to the TRACON facility. Each utility service line feeds a step-down (480/277V) transformer with grounded wye secondary windings. One transformer output feeds SWGR 1 through circuit breaker 1M1. The other output feeds SWGR 2 through circuit breaker 2M1.

a. Substation Transformers. The facility’s utility transformers are oil-filled, completely enclosed, outdoor type units, each comprising of transforming and outgoing sections.

(1) Transforming Section. The transforming section includes the transformer, the manual no-load tap changers, and the National Electrical Manufacturers Association (NEMA) standard transformer accessories.

(2) Outgoing Section. The outgoing section is a metallic terminal cubical provided with terminals for the connection of low-voltage feeders.

b. Transformer Primary Voltages and Ratings. The transformer primary voltages, kVA ratings, and internal impedance vary among each facility, depending upon ownership and local commercial power conditions. Refer to table 2-1.

Facility Identifiers:

NCT - Northern California TRACON

HCF - Honolulu Combined Center Radar Approach Control (CERAP)

A80 - Atlanta TRACON

PCT - Potomac Consolidated TRACON

Table 2-1. Substation Transformers

Location	Primary Voltage	Secondary Voltage	Substation Transformer Ratings				Transformer Owner
	kV	V	SWGR #1 Feed		SWGR #2 Feed		
			kVA	Impedance (%)	kVA	Impedance (%)	
NCT	12.5	480Y/277	1500	5.8	1500	5.8	Sacramento Municipal Utility District
HCF	12.5	480Y/277	1500	5.8	1500	5.8	Hawaiian Electric Company, Inc.
A80	12.5	480Y/277	1500	5.8	1500	5.8	Cowetta Fayette EMC
PCT	12.5	480Y/277	2000	8.0	2000	8.0	NOVEC

203. Standby Power. All DRPDS EGs are provided by Kohler. Each Kohler EG consists of a Detroit diesel engine coupled to a Marathon generator. Site specific engine information is provided in table 2-2. If a power failure occurs on both commercial supplies, the DRPDS transitions to standby power automatically when under PMCS automatic control. Manual controls are used to transfer the facility to the standby source when the PMCS is not available or when a commercial power outage is

anticipated. The number of EGs at each facility is at least two more than are required to support facility load. The extra units provide redundancy. The standby power system can be exercised against a load bank manually or via the PMCS. If an EG exercise is in process when a commercial power failure occurs, the exercise stops and load bank loads are dropped without stopping the EGs. During operation on standby power, essential loads are shed automatically until more than one EG is on-line (except at HCF).

Table 2-2. DRPDS EG Information

Site	Detroit Diesel Engine Series	Kohler EG model	KW (FAA) Rating	Voltage Rating
A80	Series 92	750ROZD	600	480Y/277
NCT	Series 92	750ROZD	600	480Y/277
PCT	Series 2000	800ROZD4	600	480Y/277
HCF	Series 71	1000ROZD	910 *	480Y/277

*Commercial Rating

a. Diesel Engine Generators. Each EG can continuously supply rated power (kW) at 480Y/277V, 3 phase, 60 Hz, with an overload rating of 10 percent for 2 hours. The engines are stationary, 16-cylinder (HCF has 24 cylinder engines), water-cooled, 2-cycle (PCT has 4 cycle engines), turbocharged diesels designed to operate at 1,800 rpm. Engine start and control equipment is similar across the four DRPDSs. The PCT engine control equipment is slightly different as it includes a component, Detroit Diesel Electronic Control System (DDEC), that serves as an interface between the Kohler DEC 340 and engine sensors on the Detroit series 2000 engine. The DRPDS engines are cranked for starting by a set of batteries. Various built-in safety devices protect the engine during operation. Immersion heaters maintain engine jacket water temperatures above minimum limits keeping the engine in a condition that assures high starting reliability. The engine exhaust system includes a muffler and exhaust manifold blankets to reduce engine noise. An engine coolant pump, thermostatically controlled radiator bypass, and radiators located outside of the diesel generator building accomplish engine cooling.

(1) Fuel System. The fuel system provides diesel fuel to the DRPDS engine generators. Off-site fuel must be provided periodically by a fuel delivery service to maintain adequate reserve in the fuel system. The fuel system is capable of storing 12,000 gallons of diesel fuel in two 6000 gallon above ground storage tanks that are located just outside the engine generator room.

(a) The outdoor tanks provide fuel to a fuel supply manifold located inside the engine room.

(b) Indoor day tanks (one 275 gallon day tank with automatic and manual controls for each engine) take suction on the fuel supply manifold to maintain sufficient capacity to meet the fuel demand of their respective engines.

1 When a day tank's fuel level drops below approximately 50 percent, day tank controls automatically operate pumps that draw fuel off the supply manifold until the tank level reaches approximately 90 percent. Each day tank has an overflow pump that automatically activates to send excess fuel through the fuel return manifold to the outdoor storage tanks if the day tank level reaches approximately 100 percent.

2 The pump automatically deactivates when the tank level reaches approximately 90 percent. The day tank level controls are adjustable and actual level settings may vary slightly from site to site.

(c) During engine operation, the engine fuel pump draws fuel from the day tank through a fuel strainer. Fuel leaving the engine fuel pump is sent through a filter to an inlet fuel manifold.

(d) Inlet fuel manifold lines supply fuel to the engine fuel injectors. The fuel injectors inject a portion of the fuel into the engine's cylinders and pass excess fuel (for cooling and lubricating) to the fuel return lines. The amount of fuel that the injectors distribute to their cylinders is controlled by a fuel rack, which is driven by the engine governor actuator (the 800ROZD4 EGs at PCT do not utilize an actuator).

(e) Excess fuel in the return lines goes back to the day tank through a heat exchanger that maintains fuel temperature within required limits.

(f) Various aspects of the fuel system are monitored continuously. Instrumentation devices provide fuel tank level indication and level alarm annunciation in the engine room and at the PMCS. Fuel system leak detectors are installed on the storage tanks and fuel lines and monitored by devices in the engine room. The fuel system utilizes a fuel filtration system to filter out water that can accumulate in the outdoor storage tanks.

(g) Fuel system valve controls are provided in the engine room on a fuel valve control panel. The fuel valve controls are wired to the engine day tank control panels and operate in response to day tank control system signals. The fuel valve control panel and the fuel filtration controls are also wired to the PMCS to allow remote control of fuel filtering operations and fuel transfer operations between outdoor storage tanks.

(2) Engine Coolant System. A heat exchanger cooling system is utilized to maintain the engine temperature within the required operating limits. In the cooling system, an ethylene glycol mixture is drawn by the engine water pump from the heat exchanger and is forced through the engine oil cooler, cylinder block, cylinder heads, and exhaust manifolds to the thermostat housings. A bypass from the thermostat housings to the inlet side of the water pump permits circulation of coolant through the engine when the thermostats are closed. When the thermostats are open, coolant flows through the radiator where heat is removed. The heat exchanger (radiator) fan operates when the EG output voltage is sufficient enough to pick up a motor starting contactor.

(3) Engine Start System. A set of batteries, and dc starter motors are utilized to start the Kohler engine generators. When the starting circuit is closed, a small drive pinion on the armature shaft engages with the teeth on the engine flywheel ring gear to crank the engine. When the engine starts, the drive pinion disengages to prevent damaging the starter motor. The batteries source the current required to crank the engine while providing stable voltage to the electrical system. A battery charger maintains the battery charge when the engine is not running. When the engine is running, the engine alternator charges the battery.

(4) Decision-Maker (DEC-340) Controller. Each engine is controlled via a DEC-340 controller. Each controller contains a keypad and display screen for monitoring engine parameters and alarms. The light emitting diodes (LEDs) and an annunciator horn provide visual and audible warnings of abnormal engine conditions. The controller provides automatic engine shutdown and prevents the engine from cranking while severe abnormal conditions are indicated. Shutdown alarms must be reset before engines can be restarted. A selector switch provides for no-load testing, for automatic operation, and for locking out the engine to prevent cranking during maintenance activities. An emergency power off button is provided on the DEC-340 to stop the engine during potential emergencies. The controller is ultimately responsible for EG start, stop, and emergency shutdown functions, as well as displaying and annunciating the following safety warnings:

- (a) Over speed shutdown
- (b) Over crank shutdown
- (c) High coolant temperature warning/shutdown
- (d) Low oil pressure warning/shutdown
- (e) Low coolant level warning/shutdown
- (f) Emergency stop
- (g) Low battery voltage warning
- (h) Battery charger fault warning
- (i) Low fuel level warning
- (j) Not in auto warning
- (k) Defined common fault shutdown

(5) Generator Control Devices. The Kohler engine generator utilizes a Barber Colman DYNA 8000 Electronic Governor and a Magnamax Digital Voltage Regulator (DVR 2000) to control engine

output in response to signals from the DEC-340 and control devices in the paralleling switchgear (PSG).

b. PSG. The PSG is a Power-Zone III Series 2 SWGR assembly made by Square D for Kohler. The PSG assembly is comprised of seven vertical sections that can be divided into a maximum of four compartments. The PSG vertical sections have three basic configurations i.e., feeder, generator control and master control sections. Feeder vertical sections are configured with transient voltage surge suppression (TVSSs), ground fault protection and feeder breakers to supply PSG power to downstream loads. Generator control sections are configured with a generator breaker, a generator protection relay, a 2350 circuit monitor, an engine programmable logic controller (PLC) and various other indicator/control devices required to connect and operate a generator on the PSG. The master control section is configured with the PSG Master PLCs and various devices required for paralleling and system level operation. The PSG utilizes 24 and 125V dc to power PLCs and various control devices, and 120V ac to power its 2350 circuit monitors and 810D trip units. Although the PSG normally uses control power to provide 480V ac of standby power on demand to downstream loads, the PSG can provide standby power when control power is not available. The PSG can be configured to support manual or automatic operation. The PSG controls engine starts and shutdowns, engine synchronizing, engine load sharing, engine protection, and Square D DS circuit breakers to deliver 480V ac of standby power from its bus to SWGR 1, SWGR 2, the fire pump, or the load bank.

(1) Circuit Breakers. The PSG utilizes Square D DS type SWGR circuit breakers to connect generators on the PSG bus, and the PSG bus to SWGR 1, SWGR 2, the fire pump and the load bank. The breakers are mounted on slide-out rails and can be racked out and removed with an overhead crane attached to the SWGR housing. The DS breakers can be operated (opened and closed) mechanically or electrically.

(a) Normally, the DS breakers are operated electrically via control switches and PLCs.

(b) The DS breaker can be operated mechanically using levers and pushbuttons on the breaker faceplate.

(c) The PSG DS breakers feature a pushbutton for resetting the breaker after a breaker over current trip via the breaker trip unit (810D).

(d) Mechanical operation of the DS breaker does not require control power. The fire pump breaker, which is normally closed, is configured for manual operation only.

(e) Although DS breakers are similar to each other, PSG breaker sizes and accessories can be different from one breaker to another.

(f) Circuit protection is supplied by a microprocessor based Power logic RMS 810D trip unit. Breaker trip settings vary from one breaker to another and most are adjustable. All breaker trip settings are listed in the site coordination study (TI 6480.1, volume 1). Current transducers in the circuit breaker transform and deliver load current levels to the breaker trip unit that the trip unit uses to trip the breaker when a load current exceeds a trip unit setting.

(2) Monitors and Indicators. The PSG utilizes various types of instrumentation to display engine status. Square D Powerlogic CM-2350 Circuit Monitors are available at each PSG engine control panel to monitor engine output parameters. Circuit breaker 810D trip units display current, power, energy, and trip status. The 2350 Circuit Monitors and 810D trip units are networked in the PMCS to provide remote monitoring at the operator work station (OWS). The 810D trip unit also sends a fault status signal to the PMCS to disable PMCS control until the fault condition is cleared and reset at the affected breaker trip unit. Annunciator panels and a piezoceramic horn provide audible and visual annunciation of PSG and engine status. Indicator lights are provided to identify the circuit breaker position and control power availability. A synchronizing panel with synchroscope, synch lights, frequency and voltmeters is provided for manually controlling engines on the PSG. The LED diagnostic indicators are provided on various PSG devices.

(3) Control Switches. PSG control switches are provided to operate the PSG manually or automatically. When the controls are in automatic, the PSG operates automatically under PLC control. When the controls are in manual, automatic PSG operation is limited or not available and a technician must manually operate the PSG (mechanically and/or electrically) to provide full standby power at the PSG bus. The control switches are hardwired to allow a technician to electrically operate the PSG without PSG PLC control. Hardware interlocks prevent electrically closing commercial and standby power together at the PSG.

(4) PLCs. The PSG utilizes a Master PLC (Square D Modicon Quantum) and generator PLCs (Square D Modicon Compac) to manage and provide engine power. One generator PLC is located in each PSG generator section. Each generator PLC communicates with its respective DEC-340 Controller and the PSG Master PLC.

(a) The Generator PLCs are responsible for controlling engine starting and stopping, generator annunciator panel indication, automatic synchronizer operation, generator circuit breaker operation and processing the signals from the Master PLC.

(b) The PSG Master PLC, which is located in the PSG Master Section, communicates with each generator PLC, a Remote Input/Output (I/O) Drop and the PMCS Primary Controller PLC to provide overall control of the PSG. The PSG Master PLC controls system level engine start and stop functions, generator management functions, feeder breaker (S5, S6, and S7) operation, and master annunciator panel indication.

(c) When PSG controls are configured for automatic operation, the PSG PLCs can operate the PSG in EMERGENCY, SYSTEM TEST or FIRE PUMP mode. Software interlocks prevent electrically closing S6 and/or S7 into commercial power at SWGR 1 and/or 2.

(5) Engine Control Devices. In addition to the PSG PLCs, the PSG utilizes Barber Colman DYNA II Auto Synchronizers and a Barber Colman DYNA II Isochronous Load Sharing Module to control single and parallel engine operation. Crompton synch check and Basler voltage/frequency relays provide generator output status to generator PLCs. Beckwith 3420 generator protection relays

are provided to trip out engine generators that are not operating within specified limits. Two ground fault relays provide additional generator protection against ground faults.

(6) Control and Interrogation Power. The PSG utilizes 120V ac, 24V dc and 125V dc control power to monitor and provide 480V ac standby power to the main SWGR. The PSG receives two sources of 125V dc from distribution panels in the 125V dc control power system. A control circuit in the PSG, which can automatically switch between the available 125V dc sources, selects which 125V dc source is used to power PSG devices. Each PSG engine control panel receives 24V dc from its respective engine generator crank start batteries. Each PSG engine control panel sends 24V dc to the PSG master control system panel where an auctioneering diode circuit passes the highest 24V dc to control circuits in the master section. Panel critical control panel (CCP) provides 120V ac to the PSG. The dc control power must be present to electrically interlock PSG breakers with commercial breakers located in SWGR 1 and SWGR 2.

204. Essential Power. Commercial or standby power is distributed to all facility loads through essential SWGR, SWBDs, and motor control centers. The following paragraphs describe each of these components.

a. Main SWGR 1 and SWGR 2. Main SWGR 1 and SWGR 2 are Power-Zone III type Square D SWGR assemblies. Each main SWGR assembly is comprised of eight vertical sections, which can be divided into a maximum of four compartments. The eight vertical sections in main SWGR 1 and SWGR 2 have four basic configurations. Section one is configured with utility equipment. Sections two and three are configured with the main SWGR breakers along with feeder breakers, a 2350 circuit monitor and various other SWGR indication/control devices. Sections four through six (and section seven in SWGR 1) are configured with SWGR feeder circuit breakers and various other SWGR indication/control devices

Note: section four has a 2350 circuit monitor.

(1) Main SWGR 1 section eight and Main SWGR 2 section seven are configured with a TVSS, PLC rack and various other SWGR indication/control devices. Main SWGR 2 section seven is also configured with spare feeder breakers. Main SWGR section eight is configured with the Main SWGR tiebreaker along with various other SWGR indication/control devices. Main SWGR 1 and SWGR 2 are configured in a main-tie-main configuration. Each main SWGR receives 480V ac commercial or standby power through its main breakers. The tiebreaker (2M12) in SWGR 2 allows connecting SWGR 1 and SWGR 2 together in the event that either SWGR sustains a loss of power at its main breaker. Each main SWGR utilizes 125V dc to power its breaker control devices. Each main SWGR utilizes 120V ac to service circuit monitors, breaker trip units, PLC power supplies and PLC interrogation power requirements. Main SWGR 1 and SWGR 2 controls can be configured to support local or remote operation.

(a) When controls are configured for remote operation, the SWGR can operate automatically as directed by PMCS programmed subroutines or in response to technician commands

made at the PMCS OWS.

(b) When controls are configured for local operation, PMCS control is limited or not available and the technician must operate SWGR breakers at the SWGR to provide 480V ac power to downstream loads.

(2) Circuit Breakers. SWGR 1 and SWGR 2 utilize Square D Type DS circuit breakers. The circuit breakers in SWGR 1 and 2 are similar to the breakers described in paragraph 203b(1) (main SWGR DS breaker accessories vary slightly from PSG DS breaker accessories). The SWGR DS breaker trip units are wired for zone interlocking.

(3) Monitors and Indicators. Each main SWGR utilizes Square D 2350 Circuit Monitors to monitor power at the commercial main breaker, the standby main breaker and the UPS SWGR feeder breaker. Each main SWGR circuit breaker 810D trip unit provides metering (current, power, energy) and status on its respective circuit breaker. The CM-2350s and the 810Ds are networked in the PMCS to provide remote monitoring at the OWS. The 810D trip unit also sends a fault status signal to the PMCS to disable PMCS control until the fault condition is cleared and reset at the affected breaker trip unit. SWGR indicator lights identify breaker position and control power availability. The LED diagnostic indicators are provided on various SWGR devices. Each main SWGR contains metering equipment used by the utility. Remote SWGR indication is available at the PMCS OWS.

(4) Control Switches. Two switches (the REMOTE/LOCAL switch and the OPEN/CLOSE switch) are used to electrically control each SWGR circuit breaker (excluding the fire pump breaker). When the breaker REMOTE/LOCAL switch is in REMOTE, the local OPEN/CLOSE switch has no effect on breaker operation, and the breaker can only be operated from the PMCS. When the breaker REMOTE/LOCAL switch is in LOCAL, the breaker can only be operated from the breaker OPEN/CLOSE switch and the PMCS has no effect on breaker operation. Control switches are hardwired to allow a technician to electrically operate the main SWGR breakers without PLC control. Electrical hardwired interlocks prevent closing the standby main breaker and the commercial main breaker onto the same bus. Electrical hardwired interlocks prevent closing the tiebreaker while both main breakers are closed or closing a main while the other main and the tiebreaker are closed.

(5) PLCs. A Square D Quantum PLC Remote I/O Rack is installed in each main SWGR. Each remote I/O rack is part of the PMCS network. The remote I/O rack controls SWGR devices and monitors SWGR device status under the direction of the PMCS primary controller. The main SWGR remote I/O racks also interface with the engine fuel system to allow monitoring and control of the fuel system as discussed in paragraph 203a(1). When SWGR controls are configured for remote operation, the PMCS can operate SWGR 1 and/or SWGR 2 in AUTOMATIC, MANUAL or MAINTENANCE mode.

(a) In AUTOMATIC mode, the PMCS can automatically operate SWGR main and tiebreakers to restore power to loads on SWGR 1 or SWGR 2. The PMCS monitors voltage relays that continuously sense the line side of each SWGR utility main breaker. If power goes outside acceptable limits at one of the SWGR utility main breakers (1M1 or 2M1) the affected main will trip open, and

after approximately 10 seconds, the PMCS can close SWGR 2's tiebreaker (2M12) restoring power where required. When power returns and is within preset limits at the affected SWGR sensing relay for approximately 15 minutes, the PMCS can open the tiebreaker and close the affected main (1M1 or 2M1). If power goes outside acceptable limits at both SWGR utility main breakers (1M1 and 2M1) both utility mains open and the PMCS initiates a transfer to standby power. When standby power is available at S6 and/or S7, the PMCS transfers SWGR 1 and 2 to standby power by closing the standby main breakers 1M2 and 2M2.

(b) In MANUAL mode, the PMCS can operate breakers in SWGR 1 or SWGR 2 in response to selections made by the technician at the operator workstation (OWS).

(c) In MAINTENANCE mode, the PMCS can open all breakers on either SWGR. Software interlocks prevent electrically closing the SWGR 2's tiebreaker when both utility main breakers are closed or both standby main breakers are closed. Software interlocks prevent closing a standby and commercial main onto the same bus or closing the tiebreaker while a standby main is closed on one main SWGR and a commercial main is closed on the other. When a fault condition is registered by one of the SWGR breaker trip units, PMCS software inhibits automatic operations to prevent connecting the fault the PSG or both sides of the DRPDS.

(6) Voltage Sensing Relays. Basler and Diversified Electronics relays sense commercial voltage at SWGR 1 and 2. The Basler relay is an over-voltage (OV) device. The Basler relay contacts signal the PMCS when commercial voltage is above preset limits. The Diversified Electronics relay is an under-voltage (UV), phase loss, imbalance/reverse sequence, device. A pair of the Diversified relay's contacts are wired through a time delay relay to its respective utility main breaker shunt trip circuit. Other Diversified relay contacts signal the PMCS and the PSG when commercial voltage is outside of preset limits. The PMCS and PSG PLCs process the commercial voltage sensing relay signals and initiate automatic DRPDS transfer controls as required.

(7) Control Power. Each main SWGR receives two sources of redundant 125V dc from distribution panels in the 125V dc system. Both 125V dc sources enter each SWGR and are routed to a set of control relays that monitor and select which 125V dc source is used to power main SWGR devices. Panel critical control panel (CCP) provides 120V ac to each main SWGR. DC control power must be present to electrically interlock SWGR 1 and 2 main and tiebreakers.

b. SWBD 1 and SWBD 2. SWBD 1 and SWBD 2 are Square D Power Style QED SWBDs. The SWBDs are comprised of vertical sections that are divided into panels. The vertical sections that are located in the middle of each SWBD are configured with SWBD main and tiebreakers, transient voltage surge suppression (TVSS), a PLC rack and various SWBD indication/control devices. The panels at either end of each SWBD are configured with SWBD feeder breakers. Each SWBD (1 and 2) utilizes 125V dc to power breaker control devices, and 120V ac to serve PLC power supplies and PLC interrogation power requirements. Each SWBD contains an **A** bus and a **B** bus. The **A** bus normally receives power from SWGR 1 through a main breaker on **A** bus while the **B** bus normally receives power from SWGR 2 through a main breaker on **B** bus. Each SWBD has a tiebreaker that can be used to tie **A** bus and **B** bus together in the event that power is unavailable at a main breaker or maintenance

is required. SWBD 1 and SWBD 2 can be configured for remote or local operation. When controls are configured for remote operation, the SWBD main and tiebreakers can operate automatically as directed by the PMCS program or in response to technician commands made at the PMCS OWS. When the controls are configured for local operation, PMCS automatic and remote operations are limited or not available and the technician must operate main and tiebreakers at the SWBD to control power to downstream loads.

(1) Circuit Breakers. SWBD 1 and SWBD 2 utilize Merlin Gerin CK (main and tie) and Square D ME (feeder) type molded case circuit breakers. The CK breakers have motor operators and are normally operated electrically from the PMCS. When control power is not available, the CK breaker can be operated mechanically using levers and switches located on the front of the breaker. The ME breakers are not equipped with motor operators and must be operated manually. The CK breakers feature solid-state STR45sp trip units with interchangeable rating plugs. The ME breakers feature Micrologic Full-Function Trip units with interchangeable rating plugs. Breaker trip settings vary from one breaker to another and most are adjustable. All breaker trip settings are listed in the site coordination study (reference TI 6480.1, volume 1).

(2) Monitors and Indicators. The ME breaker trip units feature ammeter/trip indicators that display current in phase A, B, and C, and the peak ground fault flowing in the circuit. The ammeter/trip indicator also displays OVERLOAD, SHORT CIRCUIT, or GROUND FAULT when the circuit breaker trips on overcurrent. The SWBD indicator lights identify main and tiebreaker position and control power availability. Remote SWBD indication is available at the PMCS.

(3) Control Switches. The SWBD main and tiebreakers have a set of control switches located on the front of the SWBD that are similar to those found in SWGR 1 and SWGR 2 (reference paragraph 204a(6)). In addition, each SWBD main and tiebreaker has a reset switch to reset the breaker after an over current trip (after a breaker trips on fault current, PMCS operation is inhibited until the reset switch is operated at the affected breaker). Electrical interlocks prevent closing the tiebreaker while both main breakers are closed or closing a main breaker when the other main and the tiebreaker are closed.

(4) PLCs. A Square D Quantum PLC Remote I/O Rack is installed in SWBD 1 and SWBD 2. Each remote I/O rack is part of the PMCS network. The remote I/O rack controls SWBD devices and monitors SWBD device status under the direction of the PMCS primary controller. The remote I/O rack in SWBD 1 also monitors and controls UPS Output SWBDs to allow monitoring and control as discussed in paragraph 205d(4). When SWBD breakers are configured for remote operation, the PMCS can operate the SWBD (1 or 2) in AUTOMATIC, MANUAL or MAINTENANCE mode.

(a) In AUTOMATIC mode, the PMCS can operate main and tiebreakers in each SWBD (1 or 2) as necessary to restore power on the **A** or **B** side. An UV relay is installed on the line side of each SWBD main breaker to check for voltage from the upstream feeder breaker. The status of these relays is monitored by the PMCS. If voltage is lost to one of the main breakers (G1A or G1B) the UV relay will trip open the main and signal the PMCS. If the PMCS is in AUTOMATIC mode, the PMCS

can close the tiebreaker (G10) restoring power where required. Once power returns to either side, the UV relay for that side energizes and the PCMS can return the SWBD to normal configuration by opening G10 and closing G1A or G1B.

(b) In MANUAL mode, the PMCS can operate main and tiebreakers in SWBD 1 or SWBD 2 in response to the technician's actions at the OWS.

(c) When the technician selects MAINTENANCE mode, the PMCS opens all breakers on the selected SWBD. Software interlocks prevent closing the tiebreaker when both main breakers are closed or closing a main breaker while the other main and the tiebreaker are closed. When a fault condition is registered by one of the SWBD breaker trip units, PMCS software inhibits automatic operations to prevent connecting a fault to both sides of the DRPDS.

(5) UV Relays. Diversified Electronics UV relays are connected at the line side of each SWBD (1 and 2) main breaker. When voltage is below preset limits the UV relay trips open the affected SWBD main breaker and signals the PMCS.

(6) Control and Interrogation Power. SWBD 1 and SWBD 2 utilize 120V ac, and 125V dc control power to monitor and distribute 480V ac power to the DRPDS. SWBD control and interrogation power is similar to the Main SWGR control and interrogation power setup discussed in paragraph 204a(9).

c. MCCs. MCC 1 through 5 are Model 5 Square D MCCs. Each MCC is comprised of vertical sections that are divided into panels.

(1) The vertical sections that are located in the middle of each MCC are configured with main and tiebreakers (excluding MCC 5), a PLC rack and various MCC indication/control devices.

(2) The vertical section at both ends of each MCC is configured with feeder breakers. Each MCC (excluding MCC 5) utilizes 125V dc control power to power its breaker control devices and 120V ac to serve PLC power supplies and PLC interrogation power requirements.

(3) Each MCC (excluding MCC 5 at NCT) contains an **A** and a **B** bus. The MCC **A** bus normally receives power from SWGR 1 through a main breaker while the MCC **B** bus normally receives power from SWGR 2 through a main breaker (excluding MCC 4 and 5 at NCT). The MCC tiebreaker can be used to tie **A** bus and **B** bus together in the event that power is unavailable at the main breaker on **A** bus or **B** bus or maintenance is required.

(4) The MCCs can be configured for remote or local operation.

(a) When controls are configured for remote operation, the MCC main and tiebreakers can operate automatically as directed by the PMCS program or in response to technician commands made at the PMCS OWS.

(b) When the controls are configured for local operation, PMCS automatic and remote operations are limited or not available and the technician must operate main and tiebreakers at the MCCs to control power to downstream loads.

(5) Circuit Breakers. The MCC main and tiebreakers are Merlin Gerin Compact NSJ type molded case circuit breakers. The NSJ breakers, which have motor operators, are normally operated electrically. When control power is not available, the NSJ breaker can be operated mechanically using levers and switches located on the front of the breaker. The NSJ breakers are equipped with electronic trip units that feature adjustable protection settings. MCC feeder breakers are manually operated thermal magnetic type breakers. Feeder breakers that serve inductive loads are configured with starter contactors and overloads.

(6) Monitors and Indicators. The MCC indicator lights provide main and tiebreaker position and control power availability. Control indicator lights provide ON/OFF status of individual MCC loads. Remote indication of MCC controls and indicators is available at the PMCS.

(7) Control Switches. Each MCC has control switches that are similar to those found on the front of SWBD 1 and SWBD 2 (Reference paragraph 204b(3)). Electrical interlocks prevent closing the tiebreaker while both main breakers are closed or closing a main breaker while the other main breaker and the tiebreaker are closed.

(8) PLCs. A Square D Quantum PLC Remote I/O Rack is installed in each MCC. Each remote I/O rack is part of the PMCS network. The remote I/O rack controls MCC devices and monitors MCC device status under the direction of the PMCS primary controller (PLC control is not provided for MCC 5 at NCT). When MCC controls are configured for remote operation, the PMCS can operate MCCs in AUTOMATIC, MANUAL or MAINTENANCE mode.

(a) In AUTOMATIC mode, the PMCS can operate main and tie breakers in each MCC as necessary to restore power on the **A** or **B** side. An UV relay is installed on the line side of each MCC main breaker to check for voltage from the upstream feeder. The status of the UV relay is monitored at the PMCS Primary Controller. If voltage is lost to one of the MCC's main breakers (e.g., E1A or E1B), the UV relay will trip open the main and signal the PMCS. If the PMCS is in AUTOMATIC mode, the PMCS can close the tiebreaker (e.g., E1C) restoring power where required. Once power returns to the affected side of the MCC, the UV relay energizes, and the PCMS can return the MCC to normal configuration by opening the tiebreaker and closing the affected main breaker. When a fault condition is registered by the PMCS, PMCS software inhibits all automatic operations in the area of the fault to prevent extending the fault into other areas in the DRPDS.

(b) In MANUAL mode, the PMCS can operate breakers in the MCC in response to selections made by the technician at the OWS.

(c) When the technician selects MAINTENANCE mode, the PMCS can open all breakers on the MCC.

(9) UV Relays. Diversified Electronics UV relays are connected at the line side of each MCC main breaker. When voltage is below preset limits the UV relay trips open the affected main breaker and signals the PMCS.

(10) Control and Interrogation Power. MCCs 1 through 4 utilize 120V ac and 125V dc control power to monitor and distribute 480V ac power to the DRPDS. The MCC control and interrogation power set up is similar to the Main SWGR control and interrogation power setup discussed in paragraph 204a(7).

Note: At NCT, A80, and PCT, MCC-4 and MCC-5 are unique. MCC-4 is not fed from either SWGR 1 or SWGR 2; instead, it is supplied by MCC-1A and MCC-1B. The MCC-5 does not have a main-tie-main configuration, being fed from a single breaker located on MCC-2B. HCF only uses two MCCs.

d. Load Bank. Each facility has a 1000 kW Avtron linear load bank (HCF has a 1500 kW) used for load testing UPSs and EGs. The load bank is controlled by one of two load bank control panels. One load bank control panel serves the PSG while the other serves the UPSs. Power is delivered to the load bank through the load bank SWBD. The load bank SWBD is a SQ D Power Style QED type SWBD. The load bank SWBD contains circuit breakers, a TVSS, a PLC, and various indicator/control devices. The load bank SWBD utilizes 125V dc to power its breaker control devices and 125V ac to serve PLC power supplies and PLC interrogation power requirements. The load bank can be connected to the PSG, UPS output SWBDs, or the test UPS through load bank SWBD breakers. The load bank SWBD breakers can be electrically operated locally at the load bank SWBD or remotely at the PMCS. In remote operation, the load bank SWBD can be operated in response to technician commands made at the OWS. In LOCAL mode, PMCS operations are not available and the technician must operate breakers at the load bank SWBD to power the load bank.

(1) Circuit Breakers. The load bank SWBD utilizes Square D type MX molded case circuit breakers. The breakers, which have Square D type MA and KA motor operators are normally operated electrically, but can be operated manually when electrical control is not available. The load bank SWBD breakers are equipped with trip units. Breaker trip settings are provided in the site's coordination study (reference TI 6480.1, volume 1).

(2) Monitors and Indicators. Each load bank control panel provides a meter, control switches and various indicator lights. The load bank SWBD provides breaker position and control power available indicator lights. Remote indication of the load bank SWBD functions is provided at the PMCS.

(3) Control Switches. The load bank SWBD control switches are similar to those found on the front of SWBD 1 and SWBD 2. Electrical interlocks prevent closing more than one load bank SWBD breaker at any time. The load bank control panels feature selector switches that energize different size loads. The load bank control panels are interlocked to prevent control at both panels simultaneously.

(4) PLC. A Square D Quantum PLC Remote I/O Rack is installed in the load bank SWBD. Each remote I/O rack is part of the PMCS network. The remote I/O rack controls the load bank SWBD breakers and monitors device status under the direction of the PMCS primary controller as the primary controller.

(a) When load bank SWBD breaker controls are configured for remote operation, the PMCS can operate the load bank in AUTOMATIC or MANUAL mode.

1 In AUTOMATIC mode, the PMCS can operate multiple breakers to align the load bank to engine generators or individual UPSs. In AUTOMATIC mode, the PMCS will open breakers to secure load bank testing if a fault or outage occurs. When a fault condition is registered by the PMCS, PMCS software inhibits all automatic operations in the area of the fault to prevent extending the fault into other areas in the DRPDS.

2 In MANUAL mode, the PMCS can operate individual breakers in the load bank SWBD in response to selections made by the technician at the OWS.

(b) If the load bank SWBD breaker controls are configured for LOCAL operation, PMCS operation is not available. The PLC program contains interlocks that allow only one UPS or the PSG to connect to the load bank.

(5) Control and Interrogation Power. The Load bank SWBD utilizes 120 V ac, and 125 V dc control power to monitor and distribute 480V ac power to the DRPDS. The load bank SWBD's control and interrogation power set up is similar to the Main SWGR control and interrogation power setup discussed in paragraph 204a(7).

205. Critical Power System. The critical power distribution system consists of the UPS SWGR, UPSs, UPS output SWBDs, critical buses, PDUs, SATS and the CDPs. The following paragraphs describe the aforementioned subsystems of the critical power system.

a. UPS SWGR. The UPS Square D Power-Zone III SWGR is comprised of vertical sections, where each section is divided into a maximum of four compartments. The compartments house circuit breakers, TVSSs and indicator/control devices. The UPS SWGR utilizes 125V dc to power its breaker control devices and 125V ac to serve its breaker trip units, PLC power supplies and PLC interrogation power requirements. The UPS SWGR can be configured to support LOCAL or REMOTE modes of operation. The UPS SWGR has an **A** bus and a **B** bus. The **A** bus normally receives power from SWGR 1 through the UPS SWGR A bus main breaker while the **B** bus normally receives power from SWGR 2 through the UPS SWGR B bus main breaker. The UPS SWGR has a tiebreaker that can connect **A** bus and **B** bus together in the event that power is unavailable at one of the bus's main breakers or maintenance is required.

(1) In REMOTE mode, the SWGR can operate automatically as directed by PMCS programmed subroutines or in response to selections made by a technician at the OWS.

(2) In LOCAL mode, PMCS operations are not available and the technician must operate SWGR breakers at the SWGR to control power to downstream loads.

(3) Circuit Breakers. The UPS SWGR utilizes Square D Type DS circuit breakers. The UPS SWGR circuit breakers are similar to the breakers described in paragraph 203b(1). The UPS SWGR DS breaker trip units are wired with Main SWGR breaker trip units for zone interlocking.

(4) Monitors and Indicators. Circuit breaker 810D trip units provide local metering (current, power, and energy) and status for each circuit breaker. The 810Ds are networked in the PMCS to provide remote monitoring at the OWS. The SWGR indicator lights identify breaker position and control power availability. The UPS SWGR indicators and controls are annunciated at the PMCS.

(5) Control Switches. Two switches (the REMOTE/LOCAL switch and the OPEN/CLOSE switch) are used to electrically control each SWGR circuit breaker (excluding the fire pump breaker).

(a) When the breaker REMOTE/LOCAL switch is in REMOTE, the local OPEN/CLOSE switch has no effect on breaker operation, and the breaker can only be operated from the PMCS.

(b) When the breaker REMOTE/LOCAL switch is in LOCAL, the breaker can only be operated from the breaker OPEN/CLOSE switch and the PMCS has no effect on breaker operation.

(c) Control switches are hardwired to allow a technician to electrically operate the main SWGR breakers without PLC control. Electrical interlocks prevent closing the tiebreaker while both main breakers are closed or closing a main while the other main and the tiebreaker are closed. Electrical interlocks prevent closing UPS SWGR bypass breakers C4A or C4B while UPS output SWBD breakers U11 or U13 are closed to prevent connecting different power sources on a critical bus.

(6) PLC. A Square D Quantum PLC Remote I/O Rack is installed in the UPS SWGR. The remote I/O rack, which is part of the PMCS network, controls and monitors devices in the UPS SWGR under the direction of the PMCS Primary Controller. The UPS SWGR Remote I/O rack also monitors UPS Output SWBD voltage sensing relays and critical bus breaker alarm and auxiliary contacts. When UPS SWGR controls are configured for remote operation, the PMCS can operate UPS SWGR in AUTOMATIC or MANUAL mode.

(a) In AUTOMATIC mode, the PMCS can configure main and tiebreakers in the UPS SWGR to restore power to downstream loads.

1 The PMCS monitors an under-voltage relay that continuously senses power on the line side of each UPS SWGR main breaker. If power is lost at the line side of either of the two UPS SWGR main breakers (i.e., C1A or C1B) the under-voltage relay will trip open the main breaker where power was lost and signal the PMCS. If the PMCS is in AUTOMATIC mode, the PMCS will close the tiebreaker (i.e., C6A) restoring power to the affected area. Once power returns, the under-voltage relay energizes and the PMCS returns the UPS SWGR to normal configuration by opening the tiebreaker and

closing the affected main breaker.

2 The PMCS monitors under-voltage sensing relays that continuously sense power at the line side of UPS Output SWBD breakers (U11A and U13B) that feed the critical buses. If power is lost at the line side of either U11A or U13B, an under-voltage relay will trip open the UPS output SWBD breaker where power was lost and signal the PMCS. If the PMCS is in AUTOMATIC mode, the PMCS will (after a preset time delay) close the UPS SWGR bypass breaker restoring power to the affected critical bus. Power returns to the affected UPS output SWBD, a technician must reset the UPS output SWBD UV condition from the OWS before the PMCS can return the UPS SWGR to normal configuration (i.e., open the bypass breaker and close the affected UPS output SWBD breaker).

3 When a fault condition is registered at the PMCS, PMCS software inhibits all automatic operations in the area of the fault to prevent extending the fault into other areas in the DRPDS.

(b) In MANUAL mode, the PMCS can operate breakers in the UPS SWGR in response to selections made by the technician at the OWS. If either of the two main breakers or the tiebreaker is configured for local operation, PMCS operation is not available. Reference the TI 6480.1 volume 9 for further information on PMCS controls.

(7) UPS SWGR UV Relays. Diversified Electronics UV relays are connected at the line side of each UPS SWGR main breaker. When voltage is below preset limits the UV relay trips open the affected main breaker and signals the PMCS.

(8) UPS SWGR Control and Interrogation Power. The UPS SWGR utilizes 120V ac interrogation power, and 125V dc control power to monitor and distribute 480V ac power to the DRPDS. The UPS SWGR control and interrogation power set up is similar to the Main SWGR control and interrogation power setup discussed in paragraph 204a(7).

b. UPSs. Three Powerware 300 kVA UPSs (160 kVA at HCF) are utilized to deliver critical power to facility critical loads. An additional Powerware 80 kVA UPS is utilized as a test UPS to profile critical loads. The critical power UPSs are connected in an isolated redundant configuration in which one UPS (UPS 1) serves as the bypass source for the other two (UPS 2 and UPS 3). The isolated redundant configuration minimizes single point failure modes, (i.e., systems do not communicate via common logic). Conditioned power from UPS 2 and UPS 3 feeds power to the critical buses through output SWBDs.

(1) Each UPS is a continuous duty, solid-state, reverse transfer system that consists of a battery, solid-state charger/rectifier, inverter, static switch, control panel, and microprocessor-controlled logic (see figure 2-3 for a block diagram). Each UPS is responsible for delivering uninterruptible conditioned power to its output SWBD. During normal UPS operation, power flow is derived from the UPS Supply Bus.

(a) The ac input power is converted to dc using a full-wave, six-pulse, solid-state silicon-

controlled rectifier (SCR) charger/rectifier which supplies nominal dc voltage to the inverter while maintaining a charge to the battery.

(b) The inverter assembly, which utilizes an isolated gate bipolar transistor (IGBT) design, produces a three-phase regulated output utilizing pulse-width modulation (PWM). The inverter, through the output transformer, is connected to the UPS Output SWBD through the output contactor (K3).

(c) In the event of a utility or standby power failure, power flow is derived from the battery through the battery circuit breakers and supplied to the inverter without interruption to the critical load. With the return of utility or standby power, power flow automatically reverts back to the charger/rectifier. The UPS returns to normal operation and begins to recharge the battery.

(d) In the event of an inverter failure, the UPS will transfer its output to an internal bypass source through the static switch and bypass contactor (K4). Since the transfer to bypass occurs in less than 4 microseconds (ms), the load does not experience an interruption in power.

(e) Each UPS interfaces with the PMCS through a PMCS/UPS communication box that is connected to the UPS's RS232 communication port. The PMCS/UPS communication port interface provides monitoring capability only.

(f) UPS control operations are accomplished manually through the UPS control and monitoring panel. Each critical system UPS interfaces with the PSG, the battery monitoring system, and battery cabinet via a dry contact terminal strip located near its RS232 communication port.

(g) When less than two engines support the DRPDS, dry contacts from the PSG signal the UPS to drop out its input filter.

(h) When an alarm condition exists on the battery monitoring system, dry contacts signal the UPS to generate an UPS battery alarm. Battery cabinet disconnect switch auxiliary contacts are wired to the UPS dry contact terminal strip to signal the UPS when a battery bank is disconnected from the UPS.

(i) UPSs operate in three different modes: NORMAL, BYPASS, and BATTERY.

1 In NORMAL mode, both main input and bypass input sources are available. The UPS mode and battery switches are set to NORMAL. The UPS input circuit breaker CB1 is closed, as well as the battery contactor K2 (battery disconnect breakers for 300 kVA units) and output contactor K3 (refer to UPS block diagram in figure 2-3). Incoming ac power is rectified to dc and supplied to the dc link. The dc link voltage charges the batteries and powers the inverter, which produces an ac output through K3.

2 In the event that the inverter output fails, the UPS enters the BYPASS mode (as long as the bypass source is available). As soon as the inverter output degrades beyond internal protective

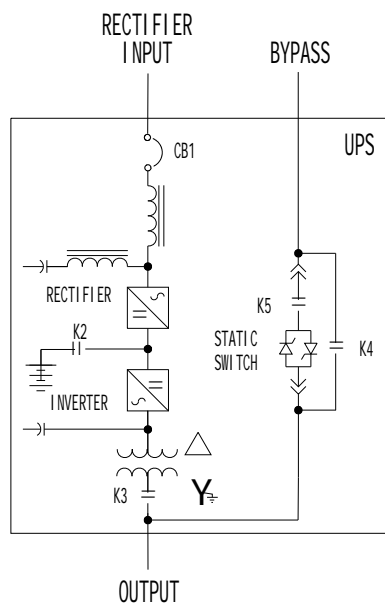
setpoints, a signal is issued simultaneously to gate the static switch, open K3 and close K4. The static switch conducts within 4 ms of the inverter failure and turns off after K4 is closed and K3 is open. This sequence of events ensures a make-before-break transfer.

3 In BATTERY mode, the UPS battery bank provides power through the UPS inverter to support the critical load. BATTERY mode occurs when UPS input power is unavailable or the UPS rectifier fails in service. Since the battery bank is connected in parallel with the rectifier, transitions between NORMAL and BATTERY modes occur without interrupting the UPS output.

(j) Proper PMCS controlled DRPDS transfers (open) between commercial and standby power sources should not interrupt power to the UPS rectifier for more than one minute. A properly maintained UPS battery bank should support the UPS's rated kW output for approximately 15 minutes and smaller kW outputs for longer periods.

(k) UPS DC expert software which must be set up properly, ensures available battery time or battery capacity is continuously monitored and displayed at the UPS graphical user interface (GUI). When BATTERY mode is initiated, the UPS alarms to alert an operator to ensure that power is restored to the UPS prior to exhausting battery bank power.

Figure 2-3. UPS Block Diagram



(2) All UPS functions are controlled by a series of microprocessor-based logic boards interconnected with an RS-485 network (Hawknet). The operator can access each board over the network with a laptop computer via a communications port. Special software is used to change UPS protective settings, view event log data, and set up automatic battery tests. The logic boards are described in the following paragraphs. For a detailed description of laptop communication and each

board's operation, refer to the TI 6480.1, volume 6.

(a) Monitor Board (A5A1). The A5A1 controls all interface functions between the operator and the UPS hardware. The board connects to an operator control panel which consists of an LCD display, six indicator lights, five pushbuttons, and an audible horn. The indicator lights provide the following information:

- 1 Normal. Indicates NORMAL mode of operation.
- 2 Battery. Indicates BATTERY mode of operation.
- 3 Bypass. Indicates BYPASS mode of operation.
- 4 Notice. Indicates active notice.

5 Alarm. If a problem is detected by any of the other control boards, an error message is sent to the monitor board. Depending on the severity of the error, the monitor board will display a notice or an alarm. A notice is an indication that an event has occurred which does not immediately jeopardize the operation of the UPS. An alarm indicates that operator intervention is required to alleviate the problem.

6 Standby. Indicates UPS in transition between modes of operation. The pushbuttons are used to navigate through the various screens available on the LCD display. The user can select between the following screens:

7 Meters. Displays UPS operational parameters such as input voltage and current, output voltage and current, input and output frequency, input and output power factor, etc.

8 Events. Displays active or past event history log, including notices, alarms, and system events such as contactors opening or closing.

9 Statistics. Displays information including number of incidents recorded in the current month and the amount of time the UPS was in OPERATIONAL modes.

10 Graphics. Displays a graphical representation of the power flow through the UPS internal components.

11 Set Up. Displays information such as system time, communication port settings, and messages.

(b) Rectifier Control Board (A4A1). The A4A1 is responsible for managing power-up and power-down functions of the rectifier, regulating the dc link, and limiting battery charge current. It senses incoming ac voltage, dc link voltage, dc current, and the rectifier heat sink temperature, and produces rectifier Silicon Controlled Rectifier (SCR) gate signals that control rectifier operation. The

microprocessor program constantly monitors all rectifier operating parameters. If a problem develops, the rectifier shuts down and sends an error message to the monitor board.

(c) Inverter Board (A4A2). The A4A2 is responsible for managing power-up and power-down functions of the inverter, output voltage regulation, output frequency regulation, and output synchronization with the bypass source. It also initiates commands to open/close the output, bypass, and battery contactors. The A4A2 senses ac bypass voltage, dc link voltage, inverter output voltage, and Insulated gated bipolar transistor (IGBT) current, and produces IGBT gate signals that control inverter operation. The microprocessor program constantly monitors all rectifier operating parameters. If a problem develops, the rectifier shuts down and initiates a transfer to bypass. It also sends an error message to the monitor board.

(d) Power Supply Boards. The power supply boards are responsible for supplying logic power to all UPS logic boards, cooling fan power and failure detection, and relay/contactors control power. The UPS utilizes four power supply boards, each fed from step-down transformers connected at various points in the UPS. One transformer is fed from the main ac input, two are fed from the bypass input, and one is fed from the UPS output. Each power supply board converts the output of one step-down transformer to dc using a full wave bridge rectifier and filter capacitors. The boards supply three 24V dc outputs, denoted A, B, and C. The A, B, or C outputs on each power supply board are daisy-chained together, respectively, through diode bridges internal to each card. These outputs feed relay and contactor control power. The B outputs provide cooling fan power, and the C outputs provide logic board power. Fan failure detection circuits on each power supply board send signals to the monitor board when any fan stops rotating. If any power supply board fails, a red LED illuminates, and the monitor board annunciates an alarm.

(e) Bypass Control Assembly (A3A1). The A3A1 is responsible for controlling the static switch SCRs and bypass contactor K4. The assembly receives logic power and a communications link from the inverter control board (A4A2). The A3A1 sends an active low signal to the A4A2 to signify the state of the assembly (on or off). The A4A2 sends active low signals to indicate bypass is available and the state of the inverter (on or off). If the inverter turns off and bypass is available, the bypass control assembly activates the bypass contactor and sends gating signals to the static switch SCRs simultaneously. After two seconds, or after the bypass contactor closes, the gate signals are removed.

c. UPS Batteries. The UPS batteries store energy for providing continuous power to the critical loads when input power is not available. Each UPS is connected to a battery cabinet that contains multiple strings of 40 high-capacity valve-regulated lead acid (VRLA) jars, each comprised of 6 cells. The number of strings (or banks) per UPS is dependent on the UPS kVA rating. The strings are connected in parallel to the dc link through battery disconnect breakers. The battery disconnect breakers are manually operated. Battery string disconnect breakers that are used in 300 kVA UPSs feature shunt trips to isolate the batteries when the UPS is shutdown.

(1) When the UPS is operating under normal conditions, the batteries maintain a float charge of approximately 13.5V dc per jar or 540V dc per battery bank. The life of individual jars is reduced if they operate above or below the optimum float charge of 13.5V dc per jar. The battery bank can supply

a full load current to the UPS inverter until the battery voltage decreases to 400.8V, or 10.02V dc per jar.

(2) VRLA batteries require cell voltage measurements, torque checks on battery connections, intercell resistance, cell impedance, and cleaning periodically to ensure optimum battery bank performance. Battery equalizing may be required to fully charge the battery bank. Equalization can decrease battery life and should be minimized. If possible, individual cell equalizing shall be done whenever a cell requires equalizing, instead of equalizing the entire battery bank. Batteries should be maintained on float charge at all times to promote battery health.

(3) Each battery string is equipped with a battery monitoring system (BMS) called a DC Tracker (BMA at PCT). The BMS continuously monitors room temperature, each battery cell voltage, and the battery string voltage. The BMS will alarm when voltage or temperature exceeds preset limits. BMS alarm contacts signal the UPS and therefore the UPS alarms whenever the BMS alarms.

d. UPS Output SWBDs. Each UPS (UPS 1, 2 and 3) is connected to a UPS Output SWBD. The UPS Output SWBDs are Square D Power Style QED SWBDs. Each UPS Output SWBD consists of a main bus, a 2350 circuit monitor, motor-operated CK type molded case circuit breakers and various SWBD indication/control devices.

(1) UPS 1's Output SWBD contains three circuit breakers (U12L, U12A and U12B) to connect its output to the Load Bank Distribution Panel, the bypass input of UPS 2, or the bypass input of UPS 3.

(2) UPS 2's Output SWBD contains two circuit breakers (U11L and U11) to connect its output to the Load Bank Distribution Panel or critical bus A.

(3) UPS 3's Output SWBD contains two circuit breakers (U13L and U13) to connect its output to the Load Bank Distribution Panel or critical B bus.

(4) The UPS Output SWBDs utilize 125V dc to power breaker control devices and 120V ac for the circuit monitor power supply and PLC interrogation power requirements. UPS Output SWBDs can be configured for remote or local operation.

(a) When controls are configured for remote operation, the SWBD main and tiebreakers can operate automatically as directed by the PMCS program or in response to technician commands made at the PMCS OWS.

(b) When the controls are configured for local operation, PMCS automatic and remote operations are limited or not available and the technician must operate breakers at the SWBD to control power to downstream loads.

(5) Circuit Breakers. UPS Output SWBDs 1, 2 and 3 utilize Square D CK type molded case circuit breakers. The CK breakers have motor operators and are normally operated electrically. When

control power is not available, the CK breaker can be operated mechanically using levers and switches located on the front of the breaker. The CK breakers feature solid-state STR45sp trip units with interchangeable rating plugs. Breaker trip settings are adjustable and are listed in the site coordination study (reference TI 6480.1, volume 1).

(6) Monitors and Indicators. UPS Output SWBD indicators identify breaker control and interrogation power. Each SWBD utilizes a CM 2350 to monitor power at the UPS output. Remote SWBD monitoring is available at the PMCS.

(7) Control Switches. Each UPS Output SWBD breakers has a set of control switches located on the front of the SWBD that are similar to those found in SWBD #1 and SWBD 2 (reference paragraph 204a(4)). Electrical breaker interlocks prevent connecting a UPS Output SWBD to a critical bus while it is connected to the load bank or vice versa. See paragraph 205a(5) for interlocks with the UPS SWGR.

(8) PLCs. Remote I/O Racks in SWBD 1 and the UPS SWGR monitor and control UPS Output SWBDs 1, 2, and 3 under the direction of the PMCS Primary Controller. When UPS Output SWBD (1, 2, or 3) breakers are configured for remote operation, the PMCS can operate the SWBD in AUTOMATIC or MANUAL mode.

(a) In AUTOMATIC mode, the PMCS can operate Output SWBD breakers to provide power to critical buses or the load bank SWBD as required. Voltage sensing relays are installed in UPS Output SWBDs 1, 2 and 3 to monitor each UPSs output. The status of these relays is monitored by the PMCS through the UPS SWGR Remote I/O Rack. If UPS voltage is not within limits at the UPS Output SWBD the voltage sensing relay will trip open the affected UPS Output SWBD breaker and signal the PMCS. If the PMCS is in AUTOMATIC mode, the PMCS will close UPS SWGR bypass breaker (C4A or C4B) restoring power to the affected critical bus after a short time delay.

(b) In MANUAL mode, the PMCS can operate breakers in response to the technician's actions at the OWS. Software interlocks prevent connecting the UPS Output SWBD to the critical bus while the critical bus is connected to the UPS SWGR bypass breaker. Software interlocks prevent connecting a UPS Output SWBD to a critical bus while the Output SWBD is connected to the load bank and vice versa. When a fault condition is registered by one of the output SWBD breaker trip units, PMCS software inhibits automatic operations to prevent connecting a fault to other equipment.

(9) Voltage Sensing Relays. Basler UV/OV relays are utilized in UPS 1 and 2's Output SWBDS. When UPS output voltage is outside preset limits the relay trips open the affected Output SWBD breaker and signals the PMCS.

(10) Control and Interrogation Power. The UPS Output SWBDs utilize 120 V ac interrogation power and 125 V dc control power to monitor and distribute UPS power. The UPS Output SWBD control and interrogation power is obtained from SWBD 1. SWBD 1's control and interrogation power set up is similar to the Main SWGR control and interrogation power setup discussed in paragraph 204a(4).

e. Critical Buses. Critical A bus and B bus are Square D I Line II plug-in style 1000A/600V ac bus way. Critical A bus receives 480 Vac from UPS Output SWBD 2 (U11) or the UPS SWGR bypass breaker C4A. Critical B bus receives 480V ac from UPS Output SWBD 3 (U13) or the UPS SWGR bypass breakers C4B. The critical buses feed power to downstream PDUs via plug in boxes with manually operated circuit breakers. PDUs 1A, 2A, 3A, and 4A (4A is not applicable (N/A) for Honolulu) are powered from Critical A bus. PDUs 1B, 2B, 3B, and 4B (4B is not applicable for HCF) are powered from Critical B bus.

(1) Circuit Breakers. UPS Output SWBDs 1, 2 and 3 utilize ME type molded case circuit breakers. The ME breakers are operated mechanically using a lever located on the front of the plug in box. The ME breakers feature Micrologic Full – function Trip units with interchangeable rating plugs. Breaker trip settings are listed in the site coordination study (see TI 6480.1, volume 1).

(2) Monitors and Indicators. The ME breaker trip units feature ammeter/trip indicators that display current in phase A, B, and C, along with peak ground fault flowing in the circuit. The ammeter/trip indicator also displays OVERLOAD, SHORT CIRCUIT, or GROUND FAULT when the circuit breaker trips.

(3) PLCs. The UPS SWGR Remote I/O Rack monitors critical bus breaker alarm and auxiliary contacts.

f. PDUs. Eight (six at HCF) Power Distribution Incorporated (PDI) PDUs are connected between the DRPDS critical buses and SATS (reference figure 2-2). The PDU lowest replaceable units (Lures) include a delta/ye transformer, an enhancer transformer module, a harmonic filter, an M4 Monitor Module, a molded case circuit breaker (MCCABE), and molded case switches (MCSW).

(1) The delta/ye transformer steps down voltage from 480V ac to 208V ac while canceling third order harmonics.

(2) The enhancer transformer module works with the delta/ye transformer to enhance the delta/ye's ability to cancel third order harmonics.

(3) The harmonic filter removes fifth and seventh order harmonics.

(4) The M4 Monitor Module displays PDU parameters and includes a printed circuit board that communicates with the PMCS.

(5) The molded case circuit breaker isolates the secondary side of the delta/ye transformer.

(6) The MCSWs isolate the PDUs input and output from the upstream critical feeds and downstream SATS. The output Macaws have motor operators and can be controlled from the PMCS to allow unloading the PDU via the OWS graphical user interface (GUI). Four PDUs (PDU-1A, 2A, 3A, and 4A) are powered from UPS 2 through critical bus A breakers U1A, U2A, U3A, and U4A (PDU4A

and breaker U4A are not used at HCF). PDUs that are fed from critical bus **A** are considered as **A** side PDUs.

(7) Four PDUs (PDU-1B, 2B, 3B, and 4B) are powered from UPS 3 through critical bus **B** breakers U1B, U2B, U3B and U4B (PDU-4B and breaker U4B are not used at HCF). PDUs that are fed from critical **B** bus are considered as **B** side PDUs.

(8) The PDUs are configured in pairs (i.e., PDU-1A is paired with PDU-1B, PDU-2A is paired with PDU-2B, etc). Each pair of PDUs is connected to a pair of SATS (i.e., PDU-1A and 1B are connected to SATS-1A and 1B etc.).

(a) Within each PDU/SATS pairing, the **A** side PDUs (e.g., PDU-1A, 2A, 3A, and 4A) feed Source 1 of the **A** side SATS (e.g., SATS-1A, 2A, 3A, and 4A) and source 1 of the **B** side SATS (e.g., SATS-1B, 2B, 3B, and 4B).

(b) The **B** side PDUs (e.g., PDU-1B, 2B, 3B, and 4B) feed Source 2 of the **A** side SATS and source 2 of the **B** side SATS. Pairing the PDU and SATS in the aforementioned configuration (reference figure 2-2) provides two sources of UPS power (i.e., UPS 2 and 3) to each SATS.

g. SATS. Eight (six at HCF) PDI SATS are connected in pairs between the DRPDS PDUs and CDPs. Each SATS is essentially a fast acting solid state transfer switch with a bypass contactor. Each SATS can connect one of two UPS sources through upstream PDUs (i.e., PDU-AX or PDU-XBOX) to one side of a downstream CDP.

(1) The SATS LRUs include a logic module, SCR module, transformer module and molded case switches.

(a) The logic module monitors and displays power parameters while providing automatic and manual operational controls for the SATS Scars and motor operated Macaws.

(b) The SCR module powers the load when the SATS is operating in STATIC mode.

(c) The transformer module transforms voltages, monitors voltages, provides voltage for Logic Module power supplies, monitors SCR module for shorted Scars and provides fuse protection.

(d) Motor operated MCSWs isolate SCR inputs and bypass SCRs when STATIC mode is not available. An additional MCSW is provided for isolating the SCR output.

(2) Each SATS provides one of two power sources (the Critical A bus PDU or Critical B bus PDU) to a CDP and its downstream loads.

(a) During normal operation, the SATS provides power from the preferred source via the SCR module in STATIC mode, while the alternate source is available but does not conduct. The microprocessor-based logic module continuously monitors both input sources and the SATS output.

(b) If the logic detects the preferred source degrading outside of normal operating characteristics, the preferred source Scars shut down and the alternate source Scars energize to supply power at the SATS output. The static (SCR) transfer between preferred and alternate sources takes less than 20 ms.

(3) Motor operated Macaws, installed inside the SATS cabinet and controlled by the microprocessor system, are used to bypass the SCR module in the event of SCR or logic failure. The PMCS monitors the SATS via a direct communications port.

h. Critical Distribution Panels (CDPs). The CDPs distribute power from upstream SATS to downstream critical panels. Each CDP contains an A and a B bus. Normally, the CDP A bus receives power from UPS 2 through an A side SATS (e.g. SATS-1A, 2A, 3A, or 4A), while the CDP B bus is powered from UPS 3 through a B side SATS (e.g., SATS-1B, 2B, 3B, and 4B). Like MCCs 1 – 4, the CDP has a tiebreaker that can be used to tie A and B bus together in the event that power is unavailable at the main breaker on A bus or B bus or maintenance is required. Unlike the MCC, the CDP has an additional feature that allows it to be hot cross-tied (close transitioned) to support maintenance requirements without affecting downstream critical loads.

(1) Each CDP is essentially a modified Model 6 Square D MCC, comprised of vertical sections that are divided into panels. The vertical sections that are located in the middle of each CDP are configured with main and tiebreakers, a PLC rack, a sync check relay, UV relays and various CDP indication/control devices. The vertical sections at either end of each CDP are configured with feeder breakers.

(2) Each CDP utilizes 125V dc control power to power its breaker control devices and 120V ac to serve PLC power supplies and PLC interrogation power requirements. The CDPs can be configured for remote or local operation. When controls are configured for remote operation, the CDP main and tiebreaker can operate automatically as directed by the PMCS program or in response to technician commands made at the PMCS OWS. When the controls are configured for local operation, PMCS automatic and remote operations are limited or not available and the technician must operate main and tiebreakers at the CDPs to control power to downstream loads.

(3) Circuit Breakers. The CDP main and tiebreakers are Square D CK type molded case circuit breakers. The CK breakers have motor operators and are normally operated electrically. When control power is not available, the CK breaker can be operated mechanically using levers and switches located on the front of the breaker. The CK breakers feature solid-state STR45sp trip units with interchangeable rating plugs. Breaker trip settings are adjustable and are listed in the site coordination study (reference TI 6480.1, volume 1). The CDP feeder breakers (i.e., load breakers) are manually operated Square D breakers with Micrologic electronic trip units for fault protection.

(4) Monitors and Indicators. The CDP indicator lights provide main and tiebreaker position and control power availability. Control indicator lights provide ON/OFF status of individual CDP loads. Remote indication of CDP controls and indicators is available at the PMCS.

(5) Control Switches. Each CDP has control switches that are similar to those found on the front of SWBD 1 and SWBD 2. Reference paragraph 204b(3). During hot cross-tie operations, an electrical interlock will open the tiebreaker to prevent allowing the tiebreaker and both main breakers from remaining closed for more than five seconds.

(6) PLCs. A Square D Quantum PLC Remote I/O Rack is installed in each CDP. Each remote I/O rack is part of the PMCS network. The remote I/O rack controls CDP devices and monitors CDP device status under the direction of the PMCS Primary Controller. When the CDP controls are configured for remote operation, the PMCS can operate CDPs in AUTOMATIC, MANUAL or MAINTENANCE mode.

In AUTOMATIC mode, the PMCS can operate main and tiebreakers in each CDP as necessary to restore power on the **A** or **B** bus. An under-voltage relay is installed on the line side of each CDP main breaker to check for voltage from the upstream SATS. The status of the under-voltage relay is monitored at the PMCS Primary Controller. If voltage drops below a set limit at the line side of one of the CDP's main breakers (e.g., CDP1-M1 or CDP1-M2), the under-voltage relay will trip open the main and signal the PMCS. If the PMCS is in AUTOMATIC mode and a current fault is not present, the PMCS can close the tiebreaker (e.g., CDP1-T) restoring power where required. When a current fault exists, PMCS software inhibits automatic operation to prevent connecting a fault to both sides of the DRPDS. Once power returns to the affected side of the CDP, the under-voltage relay energizes, and the PCMS can return the CDP to normal configuration by closing the affected main breaker (hot cross-tie or close transition) and then opening the tiebreaker.

(b) In MANUAL mode, the PMCS will operate CDP breakers in response to selections made by the technician at the PMCS OWS. Those selections include MANUAL mode CDP breaker operations as well as UNLOAD/RELOAD and/or DE-EN(DE-ENERGIZE)/RE-EN(RE-ENERGIZE) SATS, PDU and CDP operations. The PMCS will hot cross-tie (i.e., close transition) a CDP when the technician elects to UNLOAD/RELOAD its upstream SATS or PDU from the OWS. When the technician performs any manual mode PMCS OWS operations that hot cross-tie the CDP, a software interlock will open the tiebreaker if both mains and the tie remain closed for more than a few seconds.

(c) When the technician selects MAINTENANCE mode, the PMCS de-energizes or re-energizes the CDP by opening or closing all motor operated breakers.

(7) UV and synch check relays. Diversified Electronics UV relays are connected at the line side of each CDP main breaker. When voltage is below preset limits the UV relay trips open the affected main breaker and signals the PMCS. Each CDP is equipped with a synch check relay. The synch check relay monitors voltage at both main breakers. When the synch check relay sees that voltage at both main breakers is of the same magnitude and within 5 electrically degrees of each other, the tiebreaker and both main breakers can be closed at the same time.

(8) Interrogation and Control Power. CDPs 1 through 4 utilize 120V ac, and 125V dc control power to monitor and distribute 480 V ac power to the DRPDS. The CDP control and interrogation power set up is similar to the main SWGR control and interrogation power setup discussed in paragraph 204a(7).

206. System Monitoring and Control. The PMCS utilizes two personal computers along with multiple PLCs, Power Logic devices, and networks to monitor and control the DRPDS. Figure 2-4 shows a one line of the PMCS. The basic function of each component is described in the following paragraphs:

a. Operator Workstations (OWS). Two operator workstations denoted OWS-1 and OWS-2, provide remote monitoring and control of the DRPDS and its components. The OWSs are essentially Pentium based personal computers configured with communication cards (Ethernet and Mudbugs plus cards) and software packages that allow them to control the DRPDS.

(1) Hardware and software on the OWSs are configured to provide redundancy. Although the OWSs are redundant, the DRPDS can only be controlled from one of them at any time. Each OWS is configured with Microsoft NT, Square D Concept, Square D Monitor Pro, Square D SIMS 3000 and special driver software packages to monitor and control the DRPDS.

(a) Microsoft NT serves as the operating system for each OWS.

(b) Monitor Pro graphical user interface software is used to provide an object-oriented, graphical representation of the DRPDS. The program consists of numerous windows, which can be manipulated by the user with the computer mouse. The windows display system parameters, including power measurements and hardware status. Also contained in the windows are objects, or graphical representations of physical entities, which can be monitored or controlled.

(c) Square D Concept software is utilized in the OWS, to restore, modify or troubleshoot existing PLC applications.

(d) SIMS 3000 software interfaces with power logic devices to collect and trend data to maintain power quality.

(e) Each OWS is configured with various driver packages that allow it to communicate with other devices.

(2) Specific workstation hardware and software requirements are identified in the TI 6480.1, volume 9.

b. Networks. The PMCS utilizes several networks to communicate with and control DRPDS equipment. The OWSs utilize an Ethernet 10 base 2 LAN to receive information from Power Logic

circuit monitors, Power Logic circuit breaker trip units, UPSs, SATS and PDUs. Data leaves PowerLogic devices UPSs, SATS and PDUs in a serial format and is converted to Ethernet protocol via communication boxes and Ethernet gateways at the Ethernet LAN. The OWSs also utilize a Mudbugs Plus network to process information to and from the PMCS control cabinet PLCs, and the PSG master PLCs. The PMCS Control Cabinet PLCs utilize a Remote I/O network to communicate to Remote I/O PLC Drops located in DRPDS distribution equipment. The PSG Master PLCs communicate with EG Compac PLCs utilizing a Mudbugs Plus network. The PSG Master PLCs utilize a Master Remote I/O network to communicate with the Remote I/O PLC Rack inside the PSG.

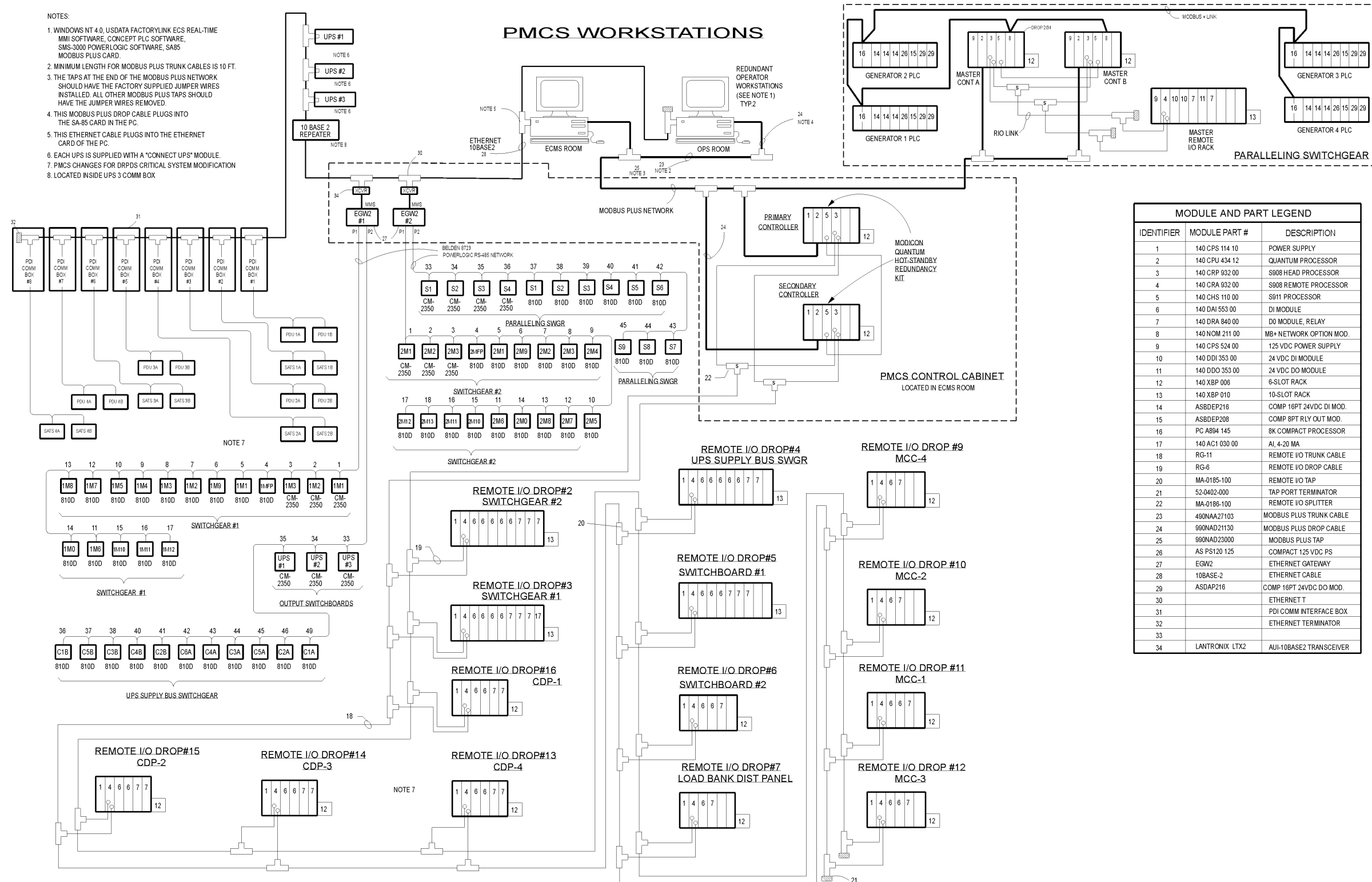


Figure 2-4. PMCS Overview

c. PLCs. The PMCS utilizes networks of PLCs configured to provide fast and reliable control of DRPDS operations.

(1) PMCS Control Cabinet Primary and Secondary Controllers. The PMCS Control Cabinet Primary and Secondary Controllers are configured as a Square D Hot Standby PLC System. The Primary and Secondary Controllers are redundant as they are physically identical and contain the same application program. Either controller can be selected as the Primary Controller.

(a) The Primary controller central processing unit (CPU) actively scans its application program and operates its remote I/O, while the Secondary Controller functions as the standby controller. The Primary Controller updates the secondary controller through the CHS modules after it completes one scan and servicing its remote I/O. The Secondary controller is ready to assume control within one scan if the Primary Controller fails.

(b) The PMCS Control Cabinet Primary Controller communicates with multiple Remote I/O PLC Drops through its RIO Head module. The Remote I/O Drops interface with SWGR 1 and SWGR 2 (refer to paragraph 204a(2)), SWBD 1 and SWBD 2 (refer to paragraph 204b(4)), the MCCs (refer to paragraph 204c(4)), the Load Bank Distribution Panel (refer to paragraph 204d(4)), the UPS SWGR (refer to paragraph 205a(3)), the UPS Output SWBDS (refer to paragraph 204b(4) and 205a(3)), and the CDPs (refer to paragraph 205h(4)).

(2) Master Controller A and B. The Master Controllers hot standby functions are identical to the PSG Master Controller hot standby functions described in paragraph 206c(1). The Master Controllers communicate with individual EG Compac PLCs and the Master Remote I/O PLC Rack (refer to paragraph 203b(4)).

207. AC/DC Control and Interrogation Power. Motor operated circuit breakers and other components such as relays, monitoring devices, and PLC racks are powered by ac or dc control power. The PLC racks also utilize ac interrogation power to identify input device status. The 125V dc and 120V ac systems provide the control and interrogation power that is required by components in the DRPDS distribution equipment.

a. 125V dc System. The dc control power system is comprised of two ac sources, a transfer switch, an ac power panel, two charger/rectifiers, two dc power panels and two battery banks.

(1) Each charger/rectifier receives an ac source from a distribution panel that is fed from a 962 ASCOT transfer switch (ASCOT 7000 Series at PCT).

(2) The transfer switch connects the switch output to one of the two-ac sources. Normally, the transfer switch is in the connected position, and the normal source supplies power to the switch output via mechanical contacts, while the emergency source is available but does not conduct. The transfer switch logic module continuously monitors both input sources and the output source. If the logic detects the preferred source degrading outside of normal operating characteristics, the switch performs an open mechanical transition to the alternate source. The transfer switch can be placed in the bypass position to allow operating the switch without affecting the load. The transfer switch receives ac power

from SWBD 1 and SWBD 2.

(3) Each charger/rectifier supplies nominal dc voltage to a battery bank.

(4) Both battery banks consist of 96 Laced XHP28AH nickel cadmium (NiCad) 1.4V cells. Each battery bank connects to a dc power panel.

(5) Both dc power panels connect to DRPDS distribution subsystems (SWGR, SWBDs, CDPs and MCCs).

(6) Each DRPDS distribution subsystem (excluding the output SWBDS that receive their two sources of dc control power from SWBD 1), receives two dc power sources, one from each dc control power panel. Within each DRPDS distribution subsystem, one of the two available dc power sources feeds a common dc bus through a set of control relays. The control relays can switch between the available dc power sources when one source is below a preset value.

b. 120V ac System. The ac control power system is comprised of two ac power sources an ASCOT 940 automatic transfer switch and an ac power panel.

(1) The two-ac sources are obtained from the critical power system.

(2) The transfer switch operates as a single pole, double throw, microprocessor-based transfer system to connect the switch output to one of the two-ac sources. Under normal operation, the normal source supplies power to the switch output via mechanical contacts, while the emergency source is available but does not conduct. The switch logic module continuously monitors both input sources and the output source. If the logic detects the normal source degrading outside of preset limits, the switch performs an open mechanical transition to the emergency source. The transfer switch can also be placed in MANUAL mode and operated locally via control switches.

(3) The transfer switch output feeds an ac power panel. The ac power panel distributes power to all DRPDS distribution subsystems (i.e., SWGR, SWBDs, CDPs, and MCCs) excluding the output SWBDS which receive their ac control power from SWBD 1.

Section 2. System Operation

208. Operation on Commercial Power. During normal operation, the DRPDS utilizes commercial power to source facility loads. The DRPDS is configured with two commercial power transformers. One commercial transformer feeds SWGR 1 while the other feeds SWGR 2. SWGR 2 is configured with a tiebreaker that allows it to be connected to SWGR 1. When power is available at both commercial transformers, and no DRPDS maintenance is underway, the tiebreaker between SWGR 1 and 2 is open and SWGR 1 and SWGR 2 feed their downstream distribution equipment independent from one another. During routine operating periods with all loads on commercial power, manual operator activities are minimal and require only that periodic inspection and verification of system status be performed. Controls and indicators shall be verified at the PMCS and at each subsystem as necessary to verify DRPDS status. If any control switches or indicators are other than specified in the following paragraphs when operating on commercial power, the trouble/maintenance should be identified/completed; and the system restored to the proper configuration as soon as practical. Operation of the DRPDS shall be coordinated with appropriate supervisory personnel.

a. PMCS. Controls, indicators, and alarms for maintaining the facility electrical system are provided on PMCS OWS GUI windows or screens. DC control and AC interrogation power must be available and DRPDS equipment breaker controls and interlocks must be set for remote breaker operation for the PMCS to operate properly. If the PMCS is not available, monitor and control must be done locally at each DRPDS subsystem. The PMCS OWS should be online and the graphical user interface windows should display the following conditions:

(1) All alarms on the OWS GUI Alarm Viewer window are acknowledged. Alarms that are locked in must be evaluated to identify if and to what extent system operational capabilities are affected.

(2) All breaker control groups on the OWS GUI ONE-LINE window are in AUTO.

(3) OWS 1 or OWS 2 has the READ function ENABLED.

(4) TRANSFER DISABLED is inactive.

b. SWGR 1 and SWGR 2. 1M1 and 2M1 are closed or 2M12 and 1M1 or 2M1 are closed to power SWGR 1 and 2 from commercial power. 1M3 through 1M9 and/or 2M3 through 2M9 are closed as necessary to power facility essential loads. Under voltage (UV) and over voltage (OV) devices are not activated. The SWGR control power is available and controls are set remote operation. The commercial power, monitored by circuit monitors at 1M1 and 2M1, is within limits identified in the standards and tolerances (chapter 3).

c. PSG. Circuit breakers S1 through S6 shall be open. S8 shall be closed. Lockout relays shall be in reset. The SYNCH switch, ENGINE CONTROL switch, breaker control switch shall be in the AUTO position. The Beckwith EG protection relay power supply (PS) LEDs and Relay OK LEDs shall be on while the diagnostic (DIG) LED is OFF. The PSG Master Annunciator Panel alarm lights shall de-

energized or inactive. The PSG Engine Generator Annunciator Panel alarm lights shall de-energized or inactive.

d. EGs. Engine DEC-340 Master Selector switch shall be in set to AUTO. The DEC-340 READY LED shall be energized.

e. EG Auxiliary Systems. The main tank fuel control system shall be set up for automatic operation and tank levels shall be in their normal operating bands. Day tank controls shall be in automatic and tank levels shall be in their normal operating bands. Engine radiator disconnect switches are closed and controls are set for automatic operation. Immersion heaters are controlling engine temperature. DC start system breakers and controls shall be set to support engine start operations. DC start System battery voltage and current should be within standards and tolerances.

f. SWBD 1 and SWBD 2. Circuit breakers shall be positioned as follows: 1G1A and 1G1B are closed or 1G10 and 1G1A or 1G1B are closed. 2G1A and 2G1B are closed or 2G10 and 2G1A or 2G1B are closed. SWBD control power is available and controls are set for remote operation.

g. MCCs. Circuit breakers shall be positioned as follows: E1A and E1B are closed or E1C and E1A or E1B are closed. E1A1 and/ or E1B1 are closed. E2A and E2B are closed or E2C and E2A or E2B are closed. E2B1 is closed. E3A and E3B are closed or E3C and E3A or E3B are closed. E4A and E4B are closed or E4C and E4A or E4B are closed. MCC control power is available and controls are set for remote operation.

NOTE: MCC circuit breakers E3 and E4 are N/A for HCF.

h. UPS SWGR. Circuit breakers shall be positioned as follows. C1A and C1B are closed or C6A and C1A or C1B are closed. C5A, C5B, C2A and C3B are closed. Control power is available and controls are set remote for operation.

i. UPSs. Control switches for UPS 1, UPS 2, and UPS 3 shall be positioned as follows: The UPS BATTERY switch should be in the NORMAL position. The UPS battery cabinet disconnect switches should be in the ON position. The UPS MODE switch should be in the NORMAL position. The UPS input circuit breaker CB1 should be in the ON position. There should not be any active alarms on any of the UPSs. Each UPS GUI should indicate the following: UPS ON NORMAL, SYNC TO BYPASS, LOAD ON INVERTER, and UPS ON. Each UPS DC tracker should not have any alarms. UPS input and output voltage/current, UPS efficiency, kVA, kW, power factor (PF), dc link voltage/current and available battery time, shall be within expected values.

j. UPS Output SWBDS. UPS Output SWBD breakers U12A and U12B shall be closed providing inverter power from UPS 1 to the bypass input of UPS 2 and UPS 3. The UPS Output SWBD breakers U11A and U13B shall be closed connecting UPS 2 to Critical A bus and UPS 3 to Critical B bus. Control power is available and controls are set to remote operation. The critical power, monitored by circuit monitors at each output SWBD, is within limits identified in the standards and tolerances (chapter 3).

k. Critical Buses. All circuit breakers on critical bus A and B (U1A, U1B, U2A, U2B, U3A, U3B, U4A, and U4B) shall be closed.

l. PDUs. All circuit breakers and molded case switches (MCSW1, MCCB2, MCSW3 and MCSW4) shall be closed on each PDU. Control power is available and controls are set for auto/remote operation with no active alarms.

m. SATs. There shall not be any active alarms on any of the SATs. Each SATS should be configured as follows. MODE SELECT SWITCH – STATIC, AUTO RETRANSFER ENABLE – NO, AUTO MAN SELECT – AUTOMATIC, PERELMAN SOURCE SELECT – SOURCE 1 for A switches and SOURCE 2 for B switches. The SATS SWITCH STATUS PANEL should indicate as follows. SOURCE 1 AVAILABLE LED is energized. SOURCE 2 AVAILABLE LED is energized. INPUT and OUTPUT and POWER AVAILABLE LEDS are energized. SS1 LED is energized for A switches and SS2 LED is energized for B switches. BYPASS and MINT MOD LEDS are de-energized.

n. CDPs. All CDP circuit breakers shall be positioned as follows. Circuit breakers CDP-M1 and CDP-M2 are closed or CDP-T is closed and CDP-M1 or CDP-M2 is closed. Selected CP load breakers are closed as required to power facility loads. CDP breaker controls should be set as necessary to enable remote operation at the PMCS.

o. DC Control Power System. The dc control system battery charger ac input breaker shall be closed. Distribution panel breakers shall be closed. Battery charger output current and voltage shall be within standards and tolerances as indicated in chapter 3. No alarms shall be present on the battery charger. Battery electrolyte levels are above low-level marks. Normal and emergency power sources are available to the dc control system transfer device and the transfer control device is set for AUTOMATIC operation.

p. AC Interrogation Power System. Normal and emergency sources of power shall be available to the transfer switch and the transfer switch controls shall be set for automatic operation. Interrogation power distribution panel breakers are closed.

209. Loss of 1M1 Commercial Feed at SWGR 1. The DRPDS is configured with two commercial transformers. One commercial transformer feeds SWGR 1 through 1M1 while the other feeds SWGR 2 through 2M1. The SWGR 2 is configured with a tiebreaker (2M12) that allows it to be connected to SWGR 1. Voltage from the two commercial transformers is continually monitored by the PMCS at 1M1 and 2M1. When the monitored voltage at 1M1 is outside specified limits, the PMCS opens 1M1 and closes the tiebreaker 2M12 between SWGR 1 and SWGR 2 to power SWGR 1 from SWGR 2 as follows:

a. Commercial voltage is monitored at 1M1 by UV and OV devices at the line side of 1M1. When commercial voltage is less than set limits at 1M1 the UV device at SWGR 1 drops out and after a set delay (see standards and tolerances in chapter 3) activates a shunt trip to open 1M1. If commercial voltage is higher than set limits at 1M1 an OV device in SWGR 1 picks up and signals the PMCS which opens 1M1 after a set time delay.

b. When 1M1 opens, UV devices on the A side of the MCCs, UPS SWGR, SWBD 1 and SWBD 2 drop out and activate shunt trips that open the following breakers:

- (1) E1A
- (2) E2A
- (3) E3A (N/A for HCF)
- (4) E4A (N/A for HCF)
- (5) C1A
- (6) 1G1A
- (7) 2G1A

Note: During the interruption of power to the UPS SWGR, the critical loads remain energized by UPS power as long as the UPSs are operating in NORMAL mode and batteries are available.

c. After all breakers on the A side open, the PMCS closes 2M12.

d. After 2M12 closes, the PMCS closes the following breakers to restore power to the A side of the DRPDS:

- (1) E1A
- (2) E2A
- (3) E3A (N/A for HCF)
- (4) E4A (N/A for HCF)
- (5) C1A
- (6) 1G1A
- (7) 2G1A

Note: If 2M12 fails to close within a set time limit, the PMCS inhibits 2M12 and closes MCC, UPS SWGR, SWBD 1 and SWBD 2 tie circuit breakers as follows:

- (8) E1C

- (9) E2C
- (10) E3C (N/A for HCF)
- (11) E4C (N/A for HCF)
- (12) C6A
- (13) 1G10C
- (14) 2G10C

210. Return of 1M1 Commercial Feed to SWGR 1. When commercial power returns to acceptable limits at 1M1, UV or OV devices pickup and signal the PMCS to start a 15-minute timer. The 15-minute timer continues to time out as long as power is good and the UV and OV devices remain picked up. After 15 minutes of acceptable commercial power at 1M1 with SWGR 1 and SWGR 2 in AUTO mode the following sequence of operations is performed automatically by the PMCS.

Note: If SWGR 1 and SWGR 2 are not in AUTO, the PMCS will not reconfigure SWGR 1 and SWGR 2 even though commercial voltage is acceptable.

a. The PMCS opens 2M12. UV devices in the MCCs, UPS SWGR, SWBD 1, and SWBD 2 drop out and activate shunt trips that open the following MCC, UPS SWGR, SWBD 1, AND SWBD 2 breakers:

- (1) E1A
- (2) E2A
- (3) E3A (N/A for HCF)
- (4) E4A (N/A for HCF)
- (5) C1A
- (6) 1G1A
- (7) 2G1A

Note: During the interruption of power to the UPS SWGR, the critical loads remain energized by UPS power as long as the UPSs are operating in NORMAL mode and batteries are available.

b. The PMCS closes 1M1. After 1M1 is closed by the PMCS, the PMCS closes the following MCC, UPS SWGR, SWBD 1, AND SWBD 2 breakers to complete power restoration:

- (1) E1A
- (2) E2A
- (3) E3A (N/A for HCF)
- (4) E4A (N/A for HCF)
- (5) C1A
- (6) 1G1A
- (7) 2G1A

211. Loss of 2M1 Commercial Feed at SWGR 2. The DRPDS is configured with two commercial transformers. One commercial transformer feeds SWGR 1 through 1M1 while the other feeds SWGR 2 through 2M1. The SWGR 2 is configured with a tiebreaker (2M12) that allows it to be connected to SWGR 1. Voltage from the two commercial transformers is continually monitored by the PMCS at the line side of 1M1 and 2M1. When the monitored voltage at 2M1 is outside specified limits, the PMCS opens 2M1 and closes the tiebreaker 2M12 between SWGR 1 and 2 to power SWGR 2 from SWGR 1 as follows:

a. Commercial voltage is monitored at 2M1 by UV and OV devices. When commercial voltage is less than set limits at 2M1 the UV device at SWGR 2 drops out and after a set delay (see standards and tolerances in chapter 3) activates a shunt trip to open 1M1. If commercial voltage is higher than set limits at 2M1 an OV device in SWGR 1 picks up and signals the PMCS which opens 2M1 after a set time delay.

b. The UV devices on the B side of the MCCs, UPS SWGR, SWBD 1, and SWBD 2 drop out and activate shunt trips that open the following breakers:

- (1) E1B
- (2) E2B
- (3) E3B (N/A for HCF)
- (4) E4B (N/A for HCF)
- (5) C1B

(6) 1G1B

(7) 2G1B

Note: During the interruption of power to the UPS SWGR, the critical loads remain energized by UPS power as long as the UPSs are operating in NORMAL mode and batteries are available.

c. After all breakers on the B side open, the PMCS closes 2M12.

d. After 2M12 closes, the PMCS closes the following breakers to restore power to the B side of the DRPDS:

(1) E1B

(2) E2B

(3) E3B (N/A for HCF)

(4) E4B (N/A for HCF)

(5) C1B

(6) 1G1B

(7) 2G1B

Note: If 2M12 fails to close within a set time limit, the PMCS inhibits 2M12 and closes MCC, UPS SWGR, SWBD 1 and SWBD 2 circuit breakers as follows:

(8) E1C

(9) E2C

(10) E3C (N/A for HCF)

(11) E4C (N/A for HCF)

(12) C6A

(13) 1G10C

(14) 2G10C

212. Return of 2M1 Commercial Feed to SWGR 2. When commercial power returns to acceptable limits at 2M1, UV or OV devices pickup and signal the PMCS to start a 15-minute timer. The 15-minute timer continues to time out as long as power is good and the UV and OV devices remain picked up. After 15 minutes of acceptable commercial power at 1M1 with SWGR 1 and SWGR 2 in AUTO the following sequence of operations is performed automatically by the PMCS.

Note: If SWGR 1 and SWGR 2 are not in AUTO, the PMCS will not reconfigure SWGR 1 and SWGR 2 even though commercial voltage is acceptable.

Note: Whenever any of the facility loads are transferred to the standby source, operation should continue in this mode for at least two hours to allow the centrifugal chiller timing controls to complete the cycle. If return to commercial power is initiated sooner, manual restarting of chillers on commercial could be prevented until completion of the timing sequence. Upon expiration of the 2-hour period the loads may be returned, providing commercial power is available and the operator is satisfied with its quality and stability.

a. The PMCS opens 2M12. UV devices in the MCCs, UPS SWGR, SWBD 1 and SWBD 2 drop out and activate shunt trips that open the following MCC, UPS SWGR, SWBD 1, and SWBD 2 breakers:

- (1) E1B
- (2) E2B
- (3) E3B (N/A for HCF)
- (4) E4B (N/A for HCF)
- (5) C1B
- (6) 1G1B
- (7) 2G1B

Note: During the interruption of power to the UPS SWGR, the critical loads remain energized by UPS power as long as the UPSs are operating in NORMAL mode and batteries are available.

b. The PMCS closes 2M1. After 2M1 is closed by the PMCS, the PMCS closes the following MCC, UPS SWGR, SWBD 1, and SWBD 2 breakers to complete power restoration:

- (1) E1B
- (2) E2B
- (3) E3B (N/A for HCF)

(4) E4B (N/A for HCF)

(5) C1B

(6) 1G1B

(7) 2G1B

213. Transfer to Standby Power. The SWGR 1 and SWGR 2 are equipped with OV and UV devices to sense commercial power upstream of 1M1 and 2M1. The OV and UV devices activate and signal the PSG and/or PMCS when voltage is outside set limits (see standard and tolerances in chapter 3). The PSG monitors UV devices in SWGR 1 and SWGR 2 as well as signals from the PMCS. The PSG will initiate EMERGENCY mode (start engines and close PSG breakers S1-S4, S6, and S7 to provide standby power), when it receives a UV from **both** SWGR 1 and SWGR 2 or when it receives a command signal from the PMCS. The PMCS monitors OV and UV devices in SWGR 1 and SWGR 2. When the PMCS sees an OV or UV at **both** SWGR 1 and SWGR 2 it signals the PSG to begin EMERGENCY mode (provide standby power). If the PMCS sees an OV or UV at SWGR 1 while SWGR 2 is not available and vice versa, the PMCS signals the PSG to begin EMERGENCY mode (provide standby power). The following sequence of system operation occurs automatically during transfers to standby power.

a. When the PMCS sends its OV/UV signal or SWGR 1 and SWGR 2 (both) send their UV signals to the PSG, the PSG initiates EMERGENCY mode and sends start signals to each available engine generator. Each available engine generator starts and ramps up to rated speed and voltage. If load bank testing is in progress and load bank breaker controls are set for remote operation, load bank breakers are opened and testing is secured. Engines that were closed onto the PSG bus during load bank testing will remain on the bus to support transfer of the DRPDS to standby power.

Note: If the transfer interrupted load bank testing, and frequency or voltage adjustments were in progress with generator controls in manual, generator output may not be optimum and further engine generator frequency and voltage adjustments may be required to provide sufficient standby power to the DRPDS.

b. When commercial voltage is less than set limits at 1M1 or 2M1, the UV device at SWGR 1 or SWGR 2 drops out and after a set delay (see standards and tolerances in chapter 3) activates a shunt trip to open 1M1 or 2M1 respectively. If commercial voltage is higher than set limits at 1M1 or 2M1, an OV device in SWGR 1 or SWGR 2 picks up and signals the PMCS which opens 1M1 and 2M1 after a set time delay.

c. When 1M1 and 2M1 open, UV devices in the MCCs, UPS SWGR, SWBD 1 and SWBD 2 drop out and activate shunt trips that open the following breakers:

(1) E1A, E1B

(2) E2A, E2B

(3) E3A, E3B (N/A for HCF)

(4) E4A, E4B (N/A for HCF)

(5) C1A, C1B

(6) 1G1A, 1G1B

(7) 2G1A, 2G1B

Note: During the transfer from commercial to standby power the critical loads will remain energized by UPS power as long as the UPSs are operating in NORMAL mode and batteries are available.

d. The first generator to achieve rated speed and voltage closes onto the PSG bus. The remaining generators synchronize to the first generator on the bus.

e. After one engine is closed onto the PSG bus, the PSG closes S6 and S7 to provide standby power to SWGR 1 and SWGR 2.

f. After the PMCS verifies that S6 and S7 close, the PMCS closes 1M2 and 2M2.

g. After 1M2 and 2M2 CLOSE, the PMCS re-closes feeder breakers to downstream equipment as follows.

(1) When less than two engines are closed onto the PSG, the PMCS inhibits feeder breaker re-closures or opens feeder breakers so only the UPS SWGR, SWBD 1, and SWBD 2 are re-energized on standby power.

(a) C1A and C1B close

(b) 1G1A and 1G1B close

(c) 2G1A and 2G1B close

(2) When two or more engines are closed onto the PSG, the PMCS closes all DRPDS feeder breakers that are not already closed to provide standby power to all facility loads.

(a) C1A and C1B close if not already closed

- (b) 1G1A and 1G1B close if not already closed
- (c) 2G1A and 2G1B close if not already closed
- (d) E1A, E1B close
- (e) E2A, E2B close
- (f) E3A, E3B close (N/A for HCF)
- (g) E4A, E4B close (N/A for HCF)

Note: The load shedding operations are not applicable to the HCF PMCS design. At HCF, all loads are restored to standby power as soon as one engine is available.

h. Approximately 1 minute after the transfer, the PMCS commands the PSG to automatically shut down the generator which has the most accumulated run time.

214. Operation on Standby Power. While operating with some or all of the facility loads on the standby source, operations personnel shall perform brief periodic reviews and verification of system status. If trouble develops, the system has appropriate safety devices and alarms to prevent equipment damage and alert personnel to areas requiring attention. With all of the loads being supplied from the standby source, the configuration of system controls and indicators should be as described in the following paragraphs. Controls and indicators shall be verified at the PMCS and at each subsystem as necessary to verify DRPDS status. If any control switches or indicators are other than specified in the following paragraphs when operating on commercial power, the trouble/maintenance should be identified/completed; and the system restored to the proper configuration as soon as practical. Operation of the DRPDS shall be coordinated with appropriate supervisory personnel.

a. PMCS. Controls, indicators, and alarms for maintaining the facility electrical system are provided on PMCS OWS GUI windows or screens. Operation of the PMCS shall be coordinated with appropriate supervisory personnel. DC control and ac interrogation power must be available and DRPDS equipment breaker controls and interlocks must be set for remote breaker operation for the PMCS to operate properly. If the PMCS is not available, monitor and control must be done locally at each DRPDS subsystem. The PMCS OWS should be on-line and the graphical user interface windows should display the following conditions:

(1) All alarms on the OWS GUI Alarm Viewer window are acknowledged. Alarms that are locked in must be evaluated to identify if and to what extent system operational capabilities are affected.

(2) All breaker control groups on the OWS GUI ONE-LINE window are in AUTO.

(3) OWS 1 or OWS 2 has the READ function ENABLED.

(4) TRANSFER DISABLED is inactive.

b. SWGR 1 and SWGR 2. 1M1 and 2M1 are open. 1M2 and 2M2 are closed or 2M12 and 1M2 or 2M2 are closed to power SWGR 1 and SWGR 2 from the PSG. 1M3 through 1M9 and/or 2M3 through 2M9 are closed. 1M9 and 2M9 shall be open if the PMCS is in LOAD SHED mode (not applicable to HCF). UV or OV devices are activated. Control power is available and controls are set for remote operation at SWGR 1 and SWGR 2.

c. PSG. Generator output circuit breakers S1 through S4 shall be closed unless engine management was initiated by the PMCS. If engine management was initiated, then three of the four engine generator output breakers should be CLOSED. S8 shall be closed and S5 shall be open. The PSG Master Annunciator Panel EMERGENCY MODE alarm light shall be energized, while all other PSG Master Annunciator Panel alarm lights shall de-energized or inactive. The PSG Engine Generator Annunciator Panel ENGINE RUNNING alarm light shall be energized while all other Engine Generator Annunciator Panel alarm lights shall be de-energized or inactive. Beckwith engine generator protection relay targets shall not be set. Beckwith relay PS LEDs and RELAY OK LEDs shall be on while the DIG LED is OFF. Standby power (kW, kVA, kNAR, V, A, PF) monitored by circuit monitors at S1 through S4 is within standards and tolerance requirements, and engines are sharing kW equally.

d. EGs. All engines shall be running unless one has been shutdown by PMCS engine management. All DEC-340 Master Selector switches shall be set to AUTO.

e. EG Auxiliaries. Engine fuel systems shall be operating in automatic with no alarms. Main tank and day tank fuel levels shall be in their normal operating bands. Engine coolant systems shall be operating in AUTO and coolant temperature shall be in the normal operating band. The exhaust fans should be running if room temperature is above controller set point. The dc start system breakers and controls shall be set to support engine start operations. The EG start system battery voltage and current shall be within standards and tolerances (chapter 3).

f. SWBD 1 and SWBD 2. Circuit breakers shall be positioned as follows. 1G1A and 1G1B are closed or 1G10 and 1G1A or 1G1B. 2G1A and 2G1B are closed or 2G10 and 2G1A or 2G1B. The SWBD control power is available and controls are set for REMOTE OPERATION.

g. MCCs. If load shed is in progress all MCC feeder breakers are open. If load shed is not in progress the circuit breakers shall be positioned as follows. E1A and E1B are closed or E1C and E1A or E1B are closed. E1A1 and/or E1B1 are closed. E2A and E2B are closed or E2C and E2A or E2B are closed. E2B1 is closed. E3A and E3B are closed or E3C and E3A or E3B are closed (N/A for HCF). E4A and E4B are closed or E4C and E4A or E4B are closed (N/A for HCF). MCC control power is available and controls are set for REMOTE OPERATION.

h. UPS SWGR. Circuit breakers shall be positioned as follows. C1A and C1B are closed or C6A and C1A or C1B are closed. C5A, C5B, C2A and C3B are closed. Control power is available and controls are set for REMOTE OPERATION.

i. UPSs. Control switches for UPS 1, UPS 2 and UPS 3 shall be positioned as follows. The UPS BATTERY switch should be in the NORMAL position. The UPS battery cabinet disconnect switches should be in the ON position. The UPS MODE switch should be in the NORMAL position. The UPS input circuit breaker CB1 should be in the ON position. There should not be any active alarms on any of the UPSs. Each UPS should indicate the following: UPS ON NORMAL, SYNC TO BYPASS, LOAD ON INVERTER, and UPS ON. Each UPS DC tracker should not have any alarms. UPS input and output voltage/current UPS efficiency, kVA, kW, pf, dc link voltage/current, and available battery time shall be within expected values.

NOTE: The UPS will provide a NOTICE that the UPS is in generator operation and inhibit closing of its input filter when only one EG is supporting the UPS supply bus. Not applicable for HCF.

j. UPS Output SWBDS. The UPS Output SWBD breakers U12A and U12B shall be closed providing inverter power from UPS 1 to the bypass input of UPS 2 and UPS 3. The UPS Output SWBD breakers U11A and U13B shall be closed connecting UPS 2 to Critical **A** bus and UPS 3 to Critical **B** bus. Control power is available and controls are set remote operation. The critical power, monitored by circuit monitors at each output SWBD, is within limits identified in the standards and tolerances.

k. Critical Buses. All circuit breakers on critical **A** bus and **B** bus (U1A, U1B, U2A, U2B, U3A, U3B, U4A, and U4B) shall be CLOSED.

l. PDUs. All circuit breakers and molded case switches (MCSW1, MCCB2, MCSW3, and MCSW4) shall be CLOSED on each PDU. Control power is available and controls are set for AUTO/REMOTE OPERATION with no active alarms.

m. SATs. There shall not be any active alarms on any of the SATS. Each SATS shall be configured as follows. MODE SELECT SWITCH – STATIC, AUTO RETRANSFER ENABLE – NO, AUTO MAN SELECT – AUTOMATIC, PERELMAN SOURCE SELECT – SOURCE 1 for **A** switches and SOURCE 2 for **B** switches. The SATS SWITCH STATUS PANEL should indicate as follows. SOURCE 1 AVAILABLE LED is energized. SOURCE 2 AVAILABLE LED is energized. INPUT and OUTPUT and POWER AVAILABLE LEDS are energized. SS1 LED is energized for **A** switches and SS2 LED is energized for **B** switches. BYPASS and MINT MOD LEDS are de-energized.

n. CDPs. All CDP circuit breakers shall be positioned as follows: Circuit breakers CDP-M1 and CDP-M2 are CLOSED or CDP-T is closed and CDP-M1 or CDP-M2 is CLOSED. Selected CP load breakers are CLOSED as required to power facility loads. The CDP breaker controls should be set as necessary to enable remote operation at the PMCS.

o. AC/DC Control and Interrogation Power Systems. The 125V dc-control system battery charger ac input breaker shall be closed. Distribution panel breakers shall be closed. Battery charger output current and voltage shall be within standards and tolerances as indicated in chapter 3. No alarms shall be present on the battery charger. Verify that battery electrolyte levels are above low-level marks. Normal and alternate power sources are available to the dc control system transfer switch and the transfer switch is set for automatic operation. Normal and alternate sources available to the ac interrogation power transfer switch and the transfer switch is set for AUTOMATIC OPERATION.

215. Return to Commercial Power. Operation with facility loads on standby power continues until the commercial voltage returns to within acceptable limits. When commercial power returns to acceptable limits at 1M1 or 2M1, UV or OV devices pickup and signal the PMCS to start a 15-minute timer. The 15-minute timer continues to time out as long as the UV and OV devices remain picked up. After 15 minutes of acceptable commercial power at 1M1 or 2M1 with SWGR 1 and SWGR 2 in AUTO mode the following sequence of operations is performed automatically by the PMCS:

Note: If SWGR 1 and SWGR 2 are not in AUTO mode, the PMCS will not return the DRPDS to commercial power even though commercial voltage is acceptable.

a. The PMCS disconnects the DRPDS from standby power by opening 1M2 and 2M2. UV devices in the MCCs, UPS SWGR, SWBD 1, and SWBD 2 drop out and activate shunt trips that open the following MCC, UPS SWGR, SWBD 1 and SWBD 2 breakers:

- (1) E1A, E1B
- (2) E2A, E2B
- (3) E3A, E3B (N/A for HCF)
- (4) E4A, E4B (N/A for HCF)
- (5) C1A, C1B
- (6) 1G1A, 1G1B
- (7) 2G1A, 2G1B

b. The PMCS returns the DRPDS to commercial power by performing one of the following sequences:

(1) If commercial voltage is within limits at SWGR 1 and SWGR 2, the PMCS closes 1M1 and 2M1. After 1M1 and 2M1 are CLOSED by the PMCS, the PMCS closes the following MCC, UPS SWGR, SWBD 1, and SWBD 2 breakers:

- (a) E1A, E1B
- (b) E2A, E2B
- (c) E3A, E3B (N/A for HCF)
- (d) E4A, E4B (N/A for HCF)
- (e) C1A, C1B
- (f) 1G1A, 1G1B
- (g) 2G1A, 2G1B

(2) If commercial voltage is within limits at SWGR 1 but out of limits at SWGR 2, the PMCS closes 1M1 and does not close 2M1. After 1M1 closes, the PMCS closes 2M12. After 2M12 has been closed, the PMCS closes MCC, UPS SWGR, SWBD 1, and SWBD 2 breakers as follows:

- (a) E1A, E1B
- (b) E2A, E2B
- (c) E3A, E3B (N/A for HCF)
- (d) E4A, E4B (N/A for HCF)
- (e) C1A, C1B
- (f) 1G1A, 1G1B
- (g) 2G1A, 2G1B

Note: If 2M12 fails to close within a set time limit, the PMCS inhibits 2M12 and closes MCC, UPS SWGR, SWBD 1, and SWBD 2 circuit breakers as follows:

- (h) E1A, E1C
- (i) E2A, E2C
- (j) E3A, E3C (N/A for HCF)

(k) E4A, E4C (N/A for HCF)

(l) C1A, C6A

(m) 1G1A, 1G10C

(n) 2G1A, 2G10C

(3) The PMCS closes 2M1 and does not close 1M1 if commercial voltage is within limits at SWGR 2 but out of limits at SWGR 1. After 2M1 closes, the PMCS closes 2M12. After 2M12 closes, the PMCS closes MCC, UPS SWGR, SWBD 1, and SWBD 2 breakers as follows:

(a) E1A, E1B

(b) E2A, E2B

(c) E3A, E3B (N/A for HCF)

(d) E4A, E4B (N/A for HCF)

(e) C1A, C1B

(f) 1G1A, 1G1B

(g) 2G1A, 2G1B

Note: If 2M12 fails to close within a set time limit, the PMCS inhibits 2M12 and closes MCC, UPS SWGR, SWBD 1, and SWBD 2 circuit breakers as follows:

(h) E1B, E1C

(i) E2B, E2C

(j) E3A, E3C (N/A for HCF)

(k) E4B, E4C (N/A for HCF)

(l) C1B, C6A

(m) 1G1B, 1G10C

(n) 2G1B, 2G10C

216. Loss and Restoration of Power at Critical Bus A. Normally, critical bus A is powered from UPS output SWBD 2 and connects through PDUs to source 1 of SATS 1A, 2A, 3A and 4A (i.e., the A side SATS) and source 2 of SATS 1B, 2B, 3B and 4B (i.e., the B side SATS).

a. When critical bus A is outside the voltage limits of downstream SATS, the A side SATS, which are normally conducting source 1 (i.e., source 1 is selected as the preferred source), statically transfer to their source 2. If power does not return to source 1 of the A and the B side SATS within a preset time limit, all of the SATS will close transition to source 2 bypass and remain there until critical bus A power is acceptable and the SATS is reset by the operator.

b. When critical bus A voltage is outside the UPS output SWBD 2 Basler OV/UV relay's limits, the OV/UV relay will trip open U11A and signal the PMCS. If critical bus A voltage remains outside specified voltage limits for several seconds, and no current faults are detected, the PMCS will close C4A to provide raw essential (bypass) power to critical bus A.

c. When power is available and within specified limits at the UPS output SWBD sensing relay, an operator must reset the PMCS OWS UV before the PMCS will open the bypass and close UPS 11A to restore UPS power to critical bus A.

Note: SATS 4A is N/A for HCF.

217. Loss and Restoration of Power at Critical Bus B. Normally, critical bus B is powered by UPS output SWBD 3 and connects through PDUs to source 2 of the A side and B side SATS.

a. When critical bus B voltage is outside the voltage limits of the downstream SATS, the B side SATS, which are normally conducting source 2 (i.e., source 2 is selected as the preferred source), statically transfer to their source 1 (i.e., critical bus A). If source 2 does not return within a preset time limit, the A side and B side SATS will close transition to bypass and remain there until critical bus B voltage is acceptable and the SATS is reset by the operator.

b. When critical bus B voltage is outside the UPS output SWBD 2 Basler OV/UV relay's limits, the OV/UV relay will trip open U13B and signal the PMCS. If critical bus B voltage remains outside specified voltage limits for several seconds, and no current faults are detected, the PMCS will close C4B to provide raw essential (bypass) power to critical bus B.

c. When power is available and within specified limits at the UPS output SWBD sensing relay, an operator must reset the PMCS OWS UV before the PMCS will open the bypass and close UPS 13B to restore UPS power to critical bus B.

Note: SATS 4A is N/A for HCF.

218. Loss and Restoration of CDP Power. Normally, each CDP is in auto, side **A** and side **B** are powered from different sources, the CDP tiebreaker is open and bus **A** and bus **B** feed downstream loads independent of each other. When the CDP is in auto, and voltage at the line side of a Cap's main breaker is outside set limits, CDP controls open the affected CDP main breaker, and close the tiebreaker to connect the two CDP sides together and power both sides from the same source. When a fault

condition is registered by one of the PMCS, PMCS software inhibits all automatic operations to prevent extending the fault into other areas in the DRPDS. When voltage returns within acceptable limits, and if the CDP is still in auto, CDP controls will re-close (i.e., close transition) the affected CDP feeder breaker and open the tiebreaker to restore the CDP to its normal configuration.

219. – 299. Reserved.

Chapter 3. Standards and Tolerances

300. General.

a. This chapter prescribes the standards and tolerances for combined TRACON DRPDS electrical systems, as defined and described in Order 6000.15C. All key performance parameters and key inspection elements are clearly identified by an arrow at the left of the applicable item. The standards and tolerances contained herein are applicable to the system taken as a whole. Some equipment standards most pertinent to proper system operation are included.

b. Entries in the reference paragraph column refer to this handbook, Orders Specifications, and TI 6480.1, volume 1 through 9. Volume references are identified by volume number, and section number, or TI 6480.1 vender publication number. Handbook references are identified by a chapter number and a paragraph number (for example: chapter 4, paragraph 442). This paragraph, 300b, lists various reference publications containing technical information and agency-oriented maintenance policy, criteria, guidelines, and procedures, much of which are generally useful and applicable to maintenance of DRPDS electrical systems. Personnel shall apply these referenced handbooks as required to supplement this handbook. In the case of conflict, this handbook shall take precedence.

- (1) TI 6480.1, Critical Power Distribution System (CPDS), Volume 1, System Overview.
- (2) TI 6480.1, Critical Power Distribution System (CPDS), Volume 2, Switchgear.
- (3) TI 6480.1, Critical Power Distribution System (CPDS), Volume 3, EGs.
- (4) TI 6480.1, Critical Power Distribution System (CPDS), Volume 4, EG Controls.
- (5) TI 6480.1, Critical Power Distribution System (CPDS), Volume 5, Switchboards and MCCs.
- (6) TI 6480.1, Critical Power Distribution System (CPDS), Volume 6, UPS).
- (7) TI 6480.1, Critical Power Distribution System (CPDS), Volume 7, SATS and PDU
- (8) TI 6480.1, Critical Power Distribution System (CPDS), Volume 8, Miscellaneous Equipment.
- (9) TI 6480.1, Critical Power Distribution System (CPDS), Volume 9, PMCS.
- (10) Order 6000.15, General Maintenance Handbook for Airway Facilities.
- (11) Order JO 6950.17A, Maintenance of Electrical Systems in Buildings.
- (12) Order JO 6950.18A, Maintenance of Electrical Distribution Systems.

- (13) Order JO 6980.11C, Maintenance of Engine Generators.
- (14) Order JO 6980.25C, Maintenance of Batteries for Standby Power.
- (15) Order 3900.19B, FAA Occupation Safety and Health Program.
- (16) Order JO 6950.22, Maintenance of Electrical Power and Control Cables.
- (17) FAA-G-2100, Electrical Equipment, General Requirements.

Standards and Tolerances

<i>Parameter</i>	<i>Reference Paragraph</i>	<i>Standard</i>	<i>Tolerance/Limit</i>	
			<i>Initial</i>	<i>Operating</i>
301. Commercial Power.				
a. Maximum substation transformer oil..... temperature (for information only)	JO 6950.18A	<95° C (203° F)	Same as standard	Same as standard
b. Dielectric strength of substation trans- former oil (for information only)	JO 6950.18A			
(1) Mineral Oil.....		> 26 kV	Same as standard	> 22 kV
(2) Synthetic Oil.....		> 30 kV	Same as standard	> 25 kV
302. Standby Power.				
a. Engine Generators	TI 6480.1 volume 3			
(1) Electric Start System.....	GS-135 (750ROZD) G5-192 (800ROZD4) G5-124 (1000ROZD) TT-680			
(a) Battery charging alternator.....				
1 Rated voltage (all DRPDS EG models)		24V dc	Same as standard	Same as standard

Standards and Tolerances (Continued)

<i>Parameter</i>	<i>Reference Paragraph</i>	<i>Standard</i>	<i>Tolerance/Limit</i>	
			<i>Initial</i>	<i>Operating</i>
<u>1</u> Rated voltage (all DRPDS EG models)		24V dc	Same as standard	Same as standard
<u>2</u> Ampere rating				
<u>a</u> 750ROZD (Series 92)		65 amps	Same as standard	Same as standard
<u>b</u> 1000ROZD (Series 71)		65 amps	Same as standard	Same as standard
<u>c</u> 800ROZD4 (Series 2000)		70 amps	Not available	Not available
(b) Starter motor rated voltage..... (all DRPDS EG models)		24V dc	Same as standard	Same as standard
(c) Battery rated voltage (all DRPDS EG models)		12V dc	Same as standard	Same as standard
(d) Battery cold cranking amps				
<u>1</u> 1000ROZD and 750ROZD		950 A (>32°F) 1250 A (<32°F)	Same as standard	Same as standard
<u>2</u> 800ROZD.....		2100 A (>32°F) 4700 A (<32°F)	Same as standard	Same as standard
(e) Battery charger	Kohler TT-680			
<u>1</u> Float voltage (all DRPDS .. EG Models)		26V dc	± 1%	± 1%
<u>2</u> Equalize voltage..... (all DRPDS EG Models)		28V dc	± 1%	± 1%
<u>3</u> Current limit (all DRPDS EG models)		10A	Same as standard	Same as standard
(2) Coolant System				
(a) Coolant operating temperature (engine outlet)				

Standards and Tolerances (Continued)

<i>Parameter</i>	<i>Reference Paragraph</i>	<i>Standard</i>	<i>Tolerance/Limit</i>	
			<i>Initial</i>	<i>Operating</i>
<u>1</u> 75 (Series 92)	TI 6480.1, volume 3, DD 92 Service Manual, chapter 5	170 to 187° F	Same as standard	Same as standard
<u>2</u> 1000ROZD (Series 71)	DD V-71 Service Manual, chapter 5	180 to 197° F	Same as standard	Same as standard
<u>3</u> 800ROZD4	Not Available	Not available	Same as standard	Same as standard
(b) Immersion Heater Operating Range				
<u>1</u> 750ROZD (Series 92)	Kohler TP 5611	ON @ 80° F OFF @ 100° F	ON @ \leq standard + 20° F OFF @ \leq standard + 20°	Same as initial
<u>2</u> 800ROZD4	Not Available		Same as standard	Same as standard
(3) Exhaust system				
(a) Exhaust flow at rated kW				
<u>1</u> 750ROZD (Series 92)	Kohler G5-135	7330 cfm	Same as standard	Same as standard
<u>2</u> 1000ROZD (Series 71)	Kohler G5-124	10120 cfm	Same as standard	Same as standard
<u>3</u> 800ROZD4	Kohler G5-192	6510 cfm	Same as standard	Same as standard
(b) Exhaust temperature at rated kW				
<u>1</u> 750ROZD(Series 92)	Kohler G5-135	725° F	Same as standard	Same as standard
<u>2</u> 1000ROZD (Series 71)	Kohler G5-124	765° F	Same as standard	Same as standard
<u>3</u> 800ROZD4	Kohler G5-192	880° F	Same as standard	Same as standard

Standards and Tolerances (Continued)

<i>Parameter</i>	<i>Reference Paragraph</i>	<i>Standard</i>	<i>Tolerance/Limit</i>	
			<i>Initial</i>	<i>Operating</i>
(c) Exhaust back pressure (maximum)				
Full load				
<u>a</u> 750ROZD (Series 92)	Kohler G5-135	2.0 in Hg	Same as standard	Same as standard
<u>b</u> 1000 ROZD (Series 71)	Kohler G5-124	2.0 in Hg	Same as standard	Same as standard
<u>c</u> 800 ROZD4 (Series 2000)	Kohler G5-192	3.0 in Hg	Same as standard	Same as standard
(4) Fuel System.				
(a) Main Tanks				
<u>1</u> Fuel grade				
<u>a</u> 800ROZD4 (Series 2000)	Kohler G5-192	No. 2 grade diesel	Same as standard	Same as standard
<u>b</u> 750ROZD (Series 92)	Kohler G5-135	No. 2 grade diesel	Same as standard	Same as standard
<u>c</u> 1000ROZD (Series 71)	Kohler G5-124	No. 2 grade diesel	Same as standard	Same as standard
<u>2</u> Minimum reserve ¹	JO 6980.11	72 hr operation	Same as standard	Same as standard
<u>3</u> Low level alarm	TI 6480.1 volume 3			
<u>a</u> PMCS.....		1684 gallons	Same as standard	Same as standard

¹ Reference firm print note in JO 6980.11.

Standards and Tolerances (Continued)

<i>Parameter</i>	<i>Reference Paragraph</i>	<i>Standard</i>	<i>Tolerance/Limit</i>	
			<i>Initial</i>	<i>Operating</i>
<u>b</u> EG Room.....		600 gallons	Same as standard	Same as standard
<u>4</u> Very low level alarm..... PMCS		600 gallons	Same as standard	Same as standard
<u>5</u> High level alarm				
<u>a</u> PMCS.....		5535 gallons	Same as standard	Same as standard
<u>b</u> EG Room.....		5535 gallons	Same as standard	Same as standard
<u>6</u> Very high level alarm..... PMCS		5922 gallons	Same as standard	Same as standard
<u>7</u> Tank capacity	Convault Owners Manual	6000 gallons each	Same as standard	Same as standard
<u>8</u> Filtration schedule.....	Fuel Guardian Operating Instructions CFI-6 Auto Drain II System TI 6480.1 volume 9	Two tank volume changes per week	Same as standard	Same as standard
(b) Day tanks	TI 6480.1 volume 3 Simplx Day Tank Operation Manual, Kohler TT-671			
<u>1</u> Capacity.....		275 gallons	Same as standard	Same as standard
<u>2</u> Normal level.....		50% to 90% full	Same as standard	Same as standard
<u>3</u> Overflow alarm		Tank 90 % full	Same as standard	Same as standard
<u>4</u> Low fuel level alarm		Tank 25% full	Same as standard	Same as standard
(c) Engine				
Fuel consumption (rated load)(gph)				

Standards and Tolerances (Continued)

Parameter	Reference Paragraph	Standard	Tolerance/Limit	
			Initial	Operating
a 750ROZD	Kohler G5-135	56.5	Same as standard	Same as standard
b 800ROZD4	Kohler G5-192	57.5	Same as standard	Same as standard
c 1000ROZD	Kohler G5-124	74.7	Same as standard	Same as standard
(5) Reserved.				
(6) Lube Oil	TI 6480.1 volume 3			
(a) Normal Operating Pressure (NOP)				
1 750ROZD @ rated speed..	DD 92 Service Manual	50 to 70 psi	Same as standard	Same as standard
2 800ROZD4 @ rated speed.	DD 92 DDC/MTU SERIES 2000 Operators Guide	80 to 120 psi	Same as standard	Same as standard
3 1000ROZD @ rated speed.	DD Series 71 Service Manual	50 to 70 psi	Same as standard	Same as standard
(b) Normal Operating Temperature (NOT)				
1 750ROZD @ rated speed..	DD Service 92 Service Manual	200 to 250° F	Same as standard	Same as standard
2 800ROZD4 @ rated speed.	DD 92 DDC/MTU SERIES 2000 Operators Guide	200 to 250° F	Same as standard	Same as standard
3 1000ROZD @ rated speed.	DD Series 71 Service Manual	200 to 250° F	Same as standard	Same as standard
b. Generators.				
→ (1) FAA Rated load (continuous)				
(a) 750ROZD		600 kW 0.8 pf	Same as standard	Same as standard

Standards and Tolerances (Continued)

Parameter	Reference Paragraph	Standard	Tolerance/Limit	
			Initial	Operating
(b) 1000ROZD (commercial..... rating)		910 kW 0.8 pf	Same as standard	Same as standard
(c) 800ROZD4		600 kW 0.8 pf	Same as standard	Same as standard
(2) Maximum load (2-h overload)				
(a) 750ROZD		660 kW @ 0.8 pf	Same as standard	Same as standard
(b) 1000ROZD		1000 kW @ 0.8 pf	Same as standard	Same as standard
(c) 800ROZD4		660 kW @ 0.8 pf	Same as standard	Same as standard
(3) Frequency				
→ (a) With steady load (All DRPDS EG models)	JO 6980.11C, para. 3-38	60 Hz	±0.3 Hz	±0.3 Hz
(b) Step load response (80% FAA rated load @ .8 pf) (All DRPDS EG models)	DTFA-02-94-B-40061	≤ 3 Hz ≤ 3second recovery time	Same as standard	Same as standard
(4) Voltage(All DRPDS EG models)				
→ (a) Voltage.....		480V ac	+/- 1V ac	+/- 1Vac
(b) Voltage regulation no load to full load (with < 0.5% drift due to temperature variation)	TI 6480.1 volume 3 Kohler G5-124 (1000ROZD), G5-135 (750ROZD), G5-192 (800ROZD)	±0.25%	Same as standard	Same as standard
(c) Step load response (80% FAA rated load @ .8 pf)	DTFA-02-94-B-40061	≤ 10% rated volts ≤ 3sec recovery time	Same as standard	Same as standard
(5) Insulation Resistance (all DRPDS EG models)	TI 6480.1 volume 3			

Standards and Tolerances (Continued)

<i>Parameter</i>	<i>Reference Paragraph</i>	<i>Standard</i>	<i>Tolerance/Limit</i>	
			<i>Initial</i>	<i>Operating</i>
(a) Main stator	Marathon Magnamax Generator Manual	1.48 megohms (minimum)	Same as standard	Same as standard
(b) Main rotor	Marathon Magnamax Generator Manual	1.5 megohms (minimum)	Same as standard	Same as standard
(c) Exciter stator	Marathon Magnamax Generator Manual	1.5 megohms (minimum)	Same as standard	Same as standard
(d) Exciter rotor	Marathon Magnamax Generator Manual	1.5 megohms (minimum)	Same as standard	Same as standard
(e) Main rotor impedance (with..... 120 V ac input)	Marathon Magnamax Generator Manual	30V ac	± 1V ac	± 1V ac
c. Engine Generator Controls				
(1) DEC 340 Shutdown Setpoints	TI 6480.1 volume 3			
(a) Over-speed.....		2,100 rpm (70 Hz)	Same as standard	Same as standard
(b) Over-voltage	FAA-G-2100G	110%	Same as standard	Same as standard
(c) Over-voltage Delay.....		5 sec	Same as standard	Same as standard
(d) Under-voltage	FAA-G-2100G	85%	Same as standard	Same as standard
(e) Under-voltage Delay		5 sec	Same as standard	Same as standard
(f) Under-frequency	TI 6480.1 volume 3	95%	Same as standard	Same as standard
(g) Under-frequency Delay.....		10 sec	Same as standard	Same as standard

Standards and Tolerances (Continued)

<i>Parameter</i>	<i>Reference Paragraph</i>	<i>Standard</i>	<i>Tolerance/Limit</i>	
			<i>Initial</i>	<i>Operating</i>
(h) Low oil pressure		11-18 psig	Same as standard	Same as standard
<u>1</u> Inhibit on startup		30 sec	Same as standard	Same as standard
<u>2</u> Delay		5 sec	Same as standard	Same as standard
(i) High coolant temp		215° F	Same as standard	Same as standard
<u>1</u> Inhibit on startup		30 sec	Same as standard	Same as standard
<u>2</u> Delay		5 sec	Same as standard	Same as standard
(j) Over-crank		3 successive cycles	Same as standard	Same as standard
<u>1</u> Engine crank cycle on		15 sec	Same as standard	Same as standard
<u>2</u> Engine crank cycle off		15 sec	Same as standard	Same as standard
(k) Locked Rotor		No speed sensor signal sensed (5 sec) during two successive crank cycles	Same as standard	Same as standard
(l) High oil temperature		250 F	Same as standard	Same as standard
<u>1</u> Inhibit on startup		30 sec	Same as standard	Same as standard
<u>2</u> Delay		5 sec	Same as standard	Same as standard
(2) Engine DEC 340 Warning Set-points				
(a) Over-current		110%	Same as standard	Same as standard
Delay		10 sec	Same as standard	Same as standard
(b) Low battery voltage		24V dc	Same as standard	Same as standard
Delay		10 sec	Same as standard	Same as standard
(c) High battery voltage		32V dc	Same as standard	Same as standard
Delay		10 sec	Same as standard	Same as standard

Standards and Tolerances (Continued)

Parameter	Reference Paragraph	Standard	Tolerance/Limit	
			Initial	Operating
(d) High coolant temp		205° F	Same as standard	Same as standard
Inhibit on startup.....		30 sec	Same as standard	Same as standard
(e) Low oil pressure		23-27 psig	Same as standard	Same as standard
Inhibit on startup.....		30 sec	Same as standard	Same as standard
(3) Engine PLC timers				
(a) Engine fail to parallel		60 sec	Same as standard	Same as standard
(b) Engine breaker fail to close..... (PSG)		3 sec	Same as standard	Same as standard
(4) PSG Engine Generator Protective ... Relay (Beckwith) Set Points	TI 6480.1 volume 8 Beckwith Generator Protection 3420 800-3420-IB-03			
(a) 24 device (Volts/Hertz)				
<u>1</u> Definite time pick up		118%	Same as standard	1%
DTPU #1 time		360 cycles	Same as standard	25cycles
delay				
<u>2</u> DTPU #2		110%	Same as standard	- 1%
DTPU #2 time delay		3600 cycles	Same as standard	25cycles
<u>3</u> Inverse time pick up		105%	Same as standard	- 1%
(ITPU)				
<u>a</u> Curve.....		1	Same as standard	Same as standard
<u>b</u> Time dial.....		10	Same as standard	Same as standard
<u>c</u> Reset rate		200 sec	Same as standard	- 3 cycles or ±1%

Standards and Tolerances (Continued)

Parameter	Reference Paragraph	Standard	Tolerance/Limit	
			Initial	Operating
(b) 32 device (phase directional power)				
<u>1</u> PU #1		-0.03	Same as standard	2%
<u>2</u> Time delay #1.....		900 cycles	Same as standard	+16 cycles or $\pm 1\%$
(c) 40 device (loss of field)				
<u>1</u> Circle diameter #1		15.8 ohms	Same as standard	$\pm .1$ ohm or $\pm 5\%$
<u>a</u> Offset		- 1.2 ohms	Same as standard	$\pm .1$ ohm or $\pm 5\%$
<u>b</u> Time delay #1		5 cycles	Same as standard	-1 to +3 cycles or $\pm 1\%$
<u>2</u> Circle diameter #2.....		48.8 ohms	Same as standard	$\pm .1$ ohm or $\pm 5\%$
<u>a</u> Offset		-1.2 ohms	Same as standard	$\pm .1$ ohm or $\pm 5\%$
<u>b</u> Time delay #2.....		30 Cycles	Same as standard	-1 to + 3 cycles or $\pm 1\%$
(d) 87 device (phase differential current)				
<u>1</u> Minimum pickup.....		0.5 Amps	Same as standard	$\pm .1$ Amp or $\pm 5\%$
<u>2</u> % slope.....		30%	Same as standard	$\pm 2\%$
<u>3</u> Time delay.....		10 cycles	Same as standard	- 1 to + 3 cycles $\pm 1\%$
(e) 59 device (OV 3 phase)				
<u>1</u> Pick up #1.....		132V ac	Same as standard	$\pm .5V$ ac or $\pm .5\%$
<u>2</u> Time delay #1.....		1800 cycles	Same as standard	+20 cycles or $\pm 1\%$
(f) 27 device (UV)				
<u>1</u> Pickup #2.....		108V ac	Same as standard	$\pm .5V$ ac or $\pm .5\%$

Standards and Tolerances (Continued)

Parameter	Reference Paragraph	Standard	Tolerance/Limit	
			Initial	Operating
<u>2</u> Time delay #2.....		1801 cycles	Same as standard	+16 cycles or $\pm 1\%$
(g) 46 device (negative sequence over current)				
<u>1</u> Definite time pickup		6 %	Same as standard	$\pm .5\%$ of 5Amps
<u>2</u> Time delay		1800 cycles	Same as standard	-1 to + 3 cycles or $\pm 1\%$
<u>3</u> Inverse time pickup.....		10 %	Same as standard	$\pm .5\%$ of 5Amps
<u>a</u> Time Dial setting		30	Same as standard	$\pm 3\%$ or ± 3 cycles
<u>b</u> Definite maximum time to trip		65500 cycles	Same as standard	-1 to + 3 cycles or $\pm 1\%$
(h) 81 device (frequency)				
<u>1</u> Pickup #1.....		57 Hz	Same as standard	$\pm .02$ Hz
<u>2</u> Time delay #1.....		120 cycles	Same as standard	-2 to +3 cycles or $\pm 1\%$
<u>3</u> Pickup #3.....		63 Hz	Same as standard	$\pm .02$ Hz
<u>4</u> Time delay #3.....		120 cycles	Same as standard	-2 to +3 cycles or $\pm 1\%$
(i) 60 FL device (fuse loss detection)				
Time delay		1800 cycles	Same as standard	-1 to +3 cycles or $\pm 1\%$
(5) PSG engine permissive relays	TI 6480.1 volume 4			
(a) Basler 27/59 (OV/UV)				
<u>1</u> Over- voltage.....		110%	Same as standard	$\pm 2.5\%$
<u>2</u> Under-voltage.....		90%	Same as standard	$\pm 2.5\%$
<u>3</u> Timing		3 Second	Same as standard	± 0.2 Sec

Standards and Tolerances (Continued)

Parameter	Reference Paragraph	Standard	Tolerance/Limit	
			Initial	Operating
(b) Basler 81 (OF/UF)				
<u>1</u> Over frequency.....		110% rated Hz	Same as standard	± 2.5%
<u>2</u> Under frequency.....		90% rated Hz	Same as standard	± 2.5%
<u>3</u> Time delay.....		3 sec	Same as standard	± 0.2 sec
(c) Crompton 25(Dead Bus)				
<u>1</u> Voltage		± 10% rated voltage	Same as standard	± 2.5%
<u>2</u> Phase Angle.....		10% or 6 electrical degrees	Same as standard	± 2.5%
(6) PSG parallel engine controls				
(a) Synchronizing.....	Barber Colman Company Technical manual DYNA II Silverline Microprocessor Auto-synchronizer (F-23448)			
<u>1</u> frequency difference		± 0.1 Hz	Same as standard	Same as standard
<u>2</u> phasing difference		± 5% to ± 20 %	Same as standard	Same as standard
<u>3</u> voltage difference.....		±1% to ±15%	Same as standard	Same as standard
(b) Load Share.....	Barber Colman Technical manual DYNA II Digital Isochronous Load Sharing Module F-22396A	± 0.5 % @ full load	Same as standard	Same as standard
303. Uninterruptible Power System (UPS).				

Standards and Tolerances (Continued)

Parameter	Reference Paragraph	Standard	Tolerance/Limit	
			Initial	Operating
a. UPS (general)	(300 kVA) Powerware 9315/9320 180- 500 kVA Service Manual (160 kVA) Powerware Plus IPM BPIII 30- 160 kVA			
→ (1) Input voltage.....		480V ac, 3 phase	-72, +48V ac	-72, +48V ac
→ (2) Input frequency		60 Hz	±3 Hz	±3 Hz
(3) AC input current (battery charge)....		125% of full load + battery charge (for overload); Actual load + 25% of full load (for battery charge) Reduced for Generator adjustable (factory set to 102%)	Same as standard	Same as standard
(4) Input current harmonic content.....		10% THD at full load (with input filter installed)	Same as standard	Same as standard
(5) Input power factor				
(a) 300 kVA		0.95 minimum	Same as standard	Same as standard
(b) 30 - 160 kVA		0.90 minimum	Same as standard	Same as standard
(6) Rectifier/Charger Capacity				
(a) 300 kVA		125%	Same as standard	Same as standard
(b) 160 kVA		115%	Same as standard	Same as standard
(c) 30-150 kVA		125%	Same as standard	Same as standard
(7) DC filtering		Ripple voltage less than 0.5% peak to peak	Same as standard	Same as standard

Standards and Tolerances (Continued)

<i>Parameter</i>	<i>Reference Paragraph</i>	<i>Standard</i>	<i>Tolerance/Limit</i>	
			<i>Initial</i>	<i>Operating</i>
→ (8) UPS output capacity.....		100% rated current at 0.8 power factor	Same as standard	Same as standard
(9) Output voltage regulation		1% (10% to 100% load)	Same as standard	Same as standard
→ (10) Output voltage adjustment.....		480V ac	± 5%	± 5%
(11) Output voltage harmonic content		3% max THD; 2% max single (for linear load)	Same as standard	Same as standard
(12) Output voltage balance (100%maximum load imbalance)				
(a) 300 kVA		3%	Same as standard	Same as standard
(b) 30-160 kVA		2%	Same as standard	Same asStandard
(13) Output voltage phase displacement (100%maximumload imbalance)				
(a) 300 kVA		3°	Same as standard	Same as standard
(b) 30-160 kVA		2°	Same as standard	Same as standard
(14) Output transients		±5% for 100% load step or removal	Same as standard	Same as standard
(15) Frequency regulation (free running)				
(a) 300 kVA		±0.01 Hz	Same as standard	Same as standard
(b) 30-160 kVA		±0.005 Hz	Same as standard	Same as standard
→ (16) Synchronous to bypass.....		Bypass within voltage limits of +5%, -8% of output setting; bypass within ±0.5 Hz.	Same as standard	Same as standard
(17) Frequency slew rate		1 Hz per second maximum (adjustable)	Same as standard	Same as standard

Standards and Tolerances (Continued)

<i>Parameter</i>	<i>Reference Paragraph</i>	<i>Standard</i>	<i>Tolerance/Limit</i>	
			<i>Initial</i>	<i>Operating</i>
(18) Overload capability 300, 30-160 kVA		125% for 10 minutes; 150% for 10 seconds; 1000% for 10 cycles with bypass	Same as standard	Same as standard
(19) Maximum output capability.....		300% peak for 10 cycles without bypass	Same as standard	Same as standard
b. UPS Rectifier Board Electrically erasable programmable read only memory (EEPROMs)	Service manual Addendum EEPROM Calibration/Setup values 30-500 kVA			
(1) Nominal input voltage	EEP 72	480V ac	Same as standard	Same as standard
(2) Input ac over-voltage (ACOV)	EEP 73	113% of nominal input voltage	Same as standard	Same as standard
(3) Input ac under-voltage (ACUV)	EEP 74	80% of nominal input voltage	Same as standard	Same as standard
(4) Nominal input frequency	EEP 75	60 Hz	Same as standard	Same as standard
(5) Input under frequency	EEP 76	56.4 Hz	Same as standard	Same as standard
(6) Input over frequency	EEP 76	63.6 Hz	Same as standard	Same as standard
(7) DC Equalize Voltage ¹	EEP 78	540V dc	Same as standard	Same as standard
(8) DC link voltage (float) ²	EEP 79	540V dc	Same as standard	Same as standard
(9) DC under-voltage (DCUV) trip	EEP 81	400.8V dc	Same as standard	Same as standard
(10) DC over-voltage (DCOV) trip	EEP 77	620V dc	Same as standard	Same as standard
(11) Over temperature alarm	EEP 91	70.6° C	Same as standard	Same as standard
(12) Over temperature trip	EEP 92	90.6° C	Same as standard	Same as standard

Standards and Tolerances (Continued)

<i>Parameter</i>	<i>Reference Paragraph</i>	<i>Standard</i>	<i>Tolerance/Limit</i>	
			<i>Initial</i>	<i>Operating</i>
(13) Battery current limit	EEP 84			
(a) 300 kVA		66.7 amps	Same as standard	Same as standard
(b) 160 kVA		35.6 amps	Same as standard	Same as standard
(c) 80 kVA.....		17.8 amps	Same as standard	Same as standard
(14) Input current limit	EEP 85			
(a) 300 kVA		552 amps	Same as standard	Same as standard
(b) 80 kVA.....		147.2 amps	Same as standard	Same as standard
(c) 160 kVA		294.4 amps	Same as standard	Same as standard
(15) On EG current limit	EEP 86			
(a) 300 kVA		528 amps	Same as standard	Same as standard
(b) 80 kVA.....		140.8 amps	Same as standard	Same as standard
(c) 160 kVA		281.6 amps	Same as standard	Same as standard
(16) Input filter pickup.....	EEP 96			
(a) 300 kVA		90 Amps	Same as standard	Same as standard
(b) 160 kVA		50 amps	Same as standard	Same as standard
(c) 80 kVA.....		37 amps	Same as standard	Same as standard
(17) Input filter dropout (see Monitor Board EEP 290)	EEP 97			
(a) 300 kVA		50 Amps	Same as standard	Same as standard
(b) 160 kVA		30 Amps	Same as standard	Same as standard
(c) 80 kVA.....		20 amps	Same as standard	Same as standard

¹When battery equalization is required by JO 6980.25, EEP 78 should be set in accordance with battery manufacturer's requirements.

²EEP float value is typical for 12 Volt URLA batteries. Refer to JO 6980.25 and battery manufacturers data for specific values.

Standards and Tolerances (Continued)

<i>Parameter</i>	<i>Reference Paragraph</i>	<i>Standard</i>	<i>Tolerance/Limit</i>	
			<i>Initial</i>	<i>Operating</i>
c. UPS Inverter Board EEPs				
(1) Inverter nominal output voltage.....	EEP 73	480V ac	Same as standard	Same as standard
(2) Inverter ACOV.....	EEP 74	110%	Same as standard	Same as standard
(3) Inverter ACUV.....	EEP 75	88% of nominal output voltage	Same as standard	Same as standard
(4) Inverter nominal output frequency ...	EEP 77	60 Hz	Same as standard	Same as standard
(5) Inverter under frequency.....	EEP 78	55 Hz	Same as standard	Same as standard
(6) Inverter over frequency.....	EEP 78	65 Hz	Same as standard	Same as standard
(7) Nominal bypass voltage.....	EEP 79	480V ac	Same as standard	Same as standard
(8) Bypass ACOV.....	EEP 80	110% Nominal	Same as standard	Same as standard
(9) Bypass ACUV.....	EEP 81	90% Nominal	Same as standard	Same as standard
(10) Bypass under frequency.....	EEP 82	59.5 Hz	Same as standard	Same as standard
(11) Bypass over frequency.....	EEP 82	60.5 Hz	Same as standard	Same as standard
(12) DCOV	EEP 85	650V dc	Same as standard	Same as standard
(13) Close battery contactor	EEP 86	480V dc	Same as standard	Same as standard
(14) Battery charged	EEP 87	504V dc	Same as standard	Same as standard
(15) Battery low voltage	EEP 88	440V dc	Same as standard	Same as standard
(16) DCUV fast.....	EEP 89	432V dc	Same as standard	Same as standard
(17) Battery DCUV	EEP 90	420V dc	Same as standard	Same as standard
(18) Battery DCUV timeout	EEP 91	180 sec	Same as standard	Same as standard
(19) Transistor Current limit.....	EEP 94			

Standards and Tolerances (Continued)

<i>Parameter</i>	<i>Reference Paragraph</i>	<i>Standard</i>	<i>Tolerance/Limit</i>	
			<i>Initial</i>	<i>Operating</i>
(a) 300 kVA		1400 amps	Same as standard	Same as standard
(b) 160 kVA		800 amps	Same as standard	Same as standard
(c) 80 kVA.....		450 amps	Same as standard	Same as standard
d. Monitor Board EEPS				
(1) Nominal output voltage	EEP 80	480V ac	Same as standard	Same as standard
(2) Output ACOV	EEP 84	110%	Same as standard	Same as standard
(3) ACUV	EEP 85	90%	Same as standard	Same as standard
(4) Output frequency	EEP 86	60 HZ	Same as standard	Same as standard
(5) Under/Over frequency	EEP 87	± 1.0%	Same as standard	Same as standard
(6) Output kVA rating	EEP 88			
(a) 300 kVA		300 kVA	Same as standard	Same as standard
(b) 160 kVA		160 kVA	Same as standard	Same as standard
(c) 80 kVA.....		80 kVA	Same as standard	Same as standard
(7) Output overload	EEP 90 and 91	100% for 10 minutes OR 125% for 10 seconds.	Same as standard	Same as standard
(8) Open Input filter on EG	EEP 290			
(a) PCT, NCT and A80.....		Bit 3	Same as standard	Same as standard
(b) HCF.....		Bit 2	Same as standard	Same as standard
→ e. UPS Internal Bypass				
(1) Protective transfer to bypass		≤4 ms	Same as standard	Same as standard

Standards and Tolerances (Continued)

Parameter	Reference Paragraph	Standard	Tolerance/Limit	
			Initial	Operating
(2) Manual transfer from or to bypass Transition time		Closed transition	Same as standard	Same as standard
f. UPS Battery Bank				
→ (1) Average float volts	Capacity Testing of Dynasty VRLA Batteries, Form 41-7135, table 2	13.5V dc per battery	+ 0.3V dc	+ 0.3V dc
(2) Average equalize volts		14.4 – 14.8V dc per unit	Same as standard	Same as standard
(3) Minimum battery voltage on float		13.2V dc per unit	Same as standard	Same as standard
(4) Minimum voltage at installation		12.0V dc per unit	Same as standard	NA
(5) Open circuit voltage		12.8V dc per unit	Same as standard	Same as standard
(6) Connections torque				
(a) UPS12-370/FR		52 in-lb (5.9 N-m)	65 in-lb (7.3 N-m)	Same as standard
(b) UPS12-270/FR		32 in-lb (3.6 N-m)	40 in-lb (4.5 N-m)	Same as standard
→ (7) Cell resistance (cellcorder)	Dynasty VRLA Battery Periodic maintenance Instructions Form 41-7546			
(a) Cell resistance		Baseline	20% of baseline	50% of baseline
(b) Connection resistance		Baseline	10% of baseline	20% of baseline
(8) Battery bank capacity	Dynasty VRLA Battery Periodic maintenance Instructions Form 41-7546	> 80%	Same as standard	Same as standard

Standards and Tolerances (Continued)

<i>Parameter</i>	<i>Reference Paragraph</i>	<i>Standard</i>	<i>Tolerance/Limit</i>	
			<i>Initial</i>	<i>Operating</i>
(9) Typical impedance	VRLA Battery Impedance and Conductance Testing Form 41-7546			
(a) UPS12-370/FR		2400 μ ohms	$\pm 3 \mu$ ohms	$\pm 3 \mu$ ohms
(b) UPS12-270/FR		3000 μ ohms	$\pm 5 \mu$ ohms	$\pm 5 \mu$ ohms
(10) Open circuit battery bank		$\sim 0.0V$ dc	Same as standard	Same as standard
(11) Ambient temperature	VRLA Battery Periodic maintenance Instructions Form 41-7546	25°C (77° F)	Same as standard	Same as standard
g. UPS Battery Monitoring System (DC Tracker)	Operations and Maintenance Manual for IPM DC Tracker Battery monitoring System			
(1) Under-voltage alarm		5%	Same as standard	Same as standard
(2) Over-voltage alarm		5%	Same as standard	Same as standard
(3) Discharging alarm		514.5V dc	Same as standard	Same as standard
(4) Recharging alarm		554V dc	Same as standard	Same as standard
(5) Low cell shutdown		10.0V dc	Same as standard	Same as standard
(6) Over-temperature alarm		26.5° C (79.7° F)	Same as standard	Same as standard
304. Control and Interrogation Power Systems.				
a. DC Control system.				

Standards and Tolerances (Continued)

<i>Parameter</i>	<i>Reference Paragraph</i>	<i>Standard</i>	<i>Tolerance/Limit</i>	
			<i>Initial</i>	<i>Operating</i>
(1) Battery Banks	TI 6480.1 volume 8 Operating Instructions ALCAD XHP Range-Nickel Cadmium Batteries			
→ (a) Cell voltage (on float).....		1.41V dc/cell	±0.1V dc	±0.1V dc
(b) Intercell connection resistance ..		1.43 mohms	±0.14 mohms	±0.14 mohms
(c) Connections torque.....		10 N-m	±2 N-m	±2 N-m
(2) Battery Chargers	TI 6480.1 volume 2			
(a) Input voltage.....	ALCAD SLR/SLRF Series battery Charge Operating and Service Instructions, section 1.2	120V ac, 1 phase	±10%	±10%
(b) Input frequency.....	ALCAD SLR/SLRF Series battery Charger Operating and Service Instructions, section 1.2	60 Hz	±6%	±6%
(c) DC current limit.....	ALCAD SLR/SLRF Series battery Charger Operating and Service Instructions, section 1.6	110%	Same as standard	Same as Standard

Standards and Tolerances (Continued)

<i>Parameter</i>	<i>Reference Paragraph</i>	<i>Standard</i>	<i>Tolerance/Limit</i>	
			<i>Initial</i>	<i>Operating</i>
(d) Float voltage	ALCAD SLR/SLRF Series battery Charger Operating and Service Instructions, section 1.2 & 1.8 (9 & inside cover)	135.4V dc	±0.5% (static) ±5% (dynamic)	±0.5% (static) ±5% (dynamic)
(e) Equalize voltage	ALCAD SLR/SLRF Series Battery Charger Operating and Service Instructions, section 1.2 & 1.8 (9 & inside cover)	139.2V dc	±0.5% (static) ±5% (dynamic)	±0.5% (static) ±5% (dynamic)
(f) Current limit	Operating Instructions ALCAD XHP Range-Nickel Cadmium Batteries	120% of nominal load	Same as standard	Same as standard
(g) High voltage	ALCAD SLR/SLRF Series Battery Charger Operating and Service Instructions, section 10.5	155.5V dc (1.62V dc per cell)	Same as standard	Same as standard
(h) Low Voltage	ALCAD SLR/SLRF Series battery Charger Operating and Service Instructions, section 10.5	129.6V dc (1.35V dc per cell)	Same as standard	Same as standard

Standards and Tolerances (Continued)

Parameter	Reference Paragraph	Standard	Tolerance/Limit	
			Initial	Operating
(3) ASCO 962 Automatic Transfer Switch	ASCO 962 Operators Manual			
(a) Position		Normal Source	Same as standard	Same as standard
<u>1</u> Bypass handle		Auto	Same as standard	Same as standard
<u>2</u> Isolation handle		Close	Same as standard	Same as standard
(b) Dip switch settings				
<u>1</u> S1 – retransfer to normal time delay		0 seconds	Same as standard	Same as standard
<u>2</u> S1 – override momentary outages time delay		0 seconds	Same as standard	Same as standard
<u>3</u> S2 – transfer to emergency time delay		0 seconds	Same as standard	Same as standard
<u>4</u> S3 – emergency source Voltage pickup		95%	Same as standard	Same as standard
<u>5</u> S3 – normal source Voltage pickup		95%	Same as standard	Same as standard
<u>6</u> S4 – normal source Voltage dropout		75%	Same as standard	Same as standard
<u>7</u> S4 – phase selection		Three phases	Same as standard	Same as standard
<u>8</u> S4 – frequency selection		60 Hz	Same as standard	Same as standard
<u>9</u> S5 – emergency source frequency pickup		95%	Same as standard	Same as standard
<u>10</u> S6 – commit on transfer selection		Off	Same as standard	Same as standard
(4) ASCO 7000 Transfer Switch	ASCO 7000 Operators Manual			

Standards and Tolerances (Continued)

<i>Parameter</i>	<i>Reference Paragraph</i>	<i>Standard</i>	<i>Tolerance/Limit</i>	
			<i>Initial</i>	<i>Operating</i>
(a) Position		Normal Source	Same as standard	Same as standard
<u>1</u> Bypass handle		Auto	Same as standard	Same as standard
<u>2</u> Isolation handle		Close	Same as standard	Same as standard
(b) Set points				
<u>1</u> retransfer to normal time .. delay		30 minutes	Same as standard	Same as standard
<u>2</u> override momentary		1 second	Same as standard	Same as standard
outages time delay				
<u>3</u> normal source voltage		90%	Same as standard	Same as standard
pickup				
<u>4</u> normal source voltage		85%	Same as standard	Same as standard
dropout				
<u>5</u> normal source		95%	Same as standard	Same as standard
frequency pickup				
<u>6</u> normal source		90%	Same as standard	Same as standard
frequency dropout				
<u>7</u> emergency source		90%	Same as standard	Same as standard
voltage pickup				
<u>8</u> emergency source		75%	Same as standard	Same as standard
voltage dropout				
<u>9</u> emergency source		95%	Same as standard	Same as standard
frequency pickup				
<u>10</u> emergency source.....		90%	Same as standard	Same as standard
frequency dropout				
b. AC Interrogation System.				
(1) ASCO 940 Automatic Transfer	ASCO 940 Operators Manual			
Switch				
(a) Position		Normal Source	Same as standard	Same as standard

Standards and Tolerances (Continued)

Parameter	Reference Paragraph	Standard	Tolerance/Limit	
			Initial	Operating
(b) Dip switch settings				
<u>1</u> S1 – retransfer to normal ... time delay		0 seconds	Same as standard	Same as standard
<u>2</u> S1 – override momentary... outages time delay		0 seconds	Same as standard	Same as standard
<u>3</u> S2 – transfer to emergency time delay		0 seconds	Same as standard	Same as standard
(2) S3 – emergency source Voltage pickup		95%	Same as standard	Same as standard
(3) S3 – normal source Voltage pickup		95%	Same as standard	Same as standard
(a) S4 – normal source Voltage dropout		75%	Same as standard	Same as standard
(b) S4 – phase selection.....		Single phase	Same as standard	Same as standard
(c) S4 – frequency selection.....		60 Hz	Same as standard	Same as standard
(d) S5 – emergency source frequency pickup		95%	Same as standard	Same as standard
(e) S6 – commit on transfer selection		Off	Same as standard	Same as standard
(4) ASCO 7000 Automatic transfer Switch	ASCO 7000 Operators Manual			
(a) Position		Normal Source	Same as standard	Same as standard
(b) Set points				
<u>1</u> Retransfer to normal time delay		30 minutes	Same as standard	Same as standard
<u>2</u> Override momentary source outage		1 second	Same as standard	Same as standard

Standards and Tolerances (Continued)

Parameter	Reference Paragraph	Standard	Tolerance/Limit	
			Initial	Operating
<u>3</u> Normal source voltage pickup		90%	Same as standard	Same as standard
<u>4</u> Normal source voltage dropout		85%	Same as standard	Same as standard
<u>5</u> Normal source frequency... pickup		95%	Same as standard	Same as standard
<u>6</u> Normal source frequency... dropout		90%	Same as standard	Same as standard
<u>7</u> Emergency source voltage pickup		90%	Same as standard	Same as standard
<u>8</u> Emergency source voltage dropout		75%	Same as standard	Same as standard
<u>9</u> Emergency source frequency pickup		95%	Same as standard	Same as standard
<u>10</u> Emergency source frequency dropout		90%	Same as standard	Same as standard
305. Distribution Equipment				
a. Control Relay Set points (Reference..... 3c(4)and (5) for EG Protective and Permissive Relays)	TI 6480.1 volume 4 & 9			
→ (1) SWGR 1 & 2 transfer control relays				
(a) Basler 59 480V ac A80, HCF, NCT 120V ac PCT				
<u>1</u> OV		110%	± 2.0V ac	± 2.0V ac
<u>2</u> Time delay.....		Minimum	200msec	<.7 sec
(b) Diversified Electronics 27/47 ... (480V ac)		432V ac	± 5.0V ac	± 5.0V ac

Standards and Tolerances (Continued)

Parameter	Reference Paragraph	Standard	Tolerance/Limit	
			Initial	Operating
<u>1</u> SLA 440 ALE (HCF and A80)				
UV		446V ac	Same as standard	± 2%
<u>2</u> SLD 440 ALE (NCT and PCT)				
<u>a</u> UV		446V ac	Same as standard	± 2%
<u>b</u> UV Time Delay		2.0	Same as standard	± 0.4 sec
<u>c</u> Phase Unbalance.....		4%	Same as standard	± 1%
(c) Agastat time delay				
27x-1		2 sec	Same as standard	Same as standard
(d) Diversified Electronics 27 Source Selector Relays left and right (120V dc)				
UV		107V dc	Same as standard	± 1V dc
(2) UPS SWGR transfer control relays. (480V Relay)				
(a) Diversified Electronics 27/47				
<u>1</u> UV		432V ac	± 5.0V ac	± 5.0V ac
<u>2</u> Delay		Minimum	Same as Standard	< 0.7 sec
(b) Diversified Electronics 27 Source Selector Relays left and right (120V dc)				
UV		107V dc	Same as standard	± 1V dc
(c) Agastat time delay				
27x-1		2 sec	Same as standard	Same as standard

Standards and Tolerances (Continued)

<i>Parameter</i>	<i>Reference Paragraph</i>	<i>Standard</i>	<i>Tolerance/Limit</i>	
			<i>Initial</i>	<i>Operating</i>
(3) UPS Output SWBD transfer control				
Basler 27/59 480 relay				
<u>1</u> Over-voltage.....		< 110%	± 1.0V ac	± 1.0V ac
<u>2</u> Under-voltage.....		> 90%	± 1.0V ac	± 1.0V ac
<u>3</u> Delay		Minimum	Same as standard	< 0.7 sec
(4) SWBD 1 & SWBD 2 transfer control relays				
(a) Diversified Electronics 27/47				
<u>1</u> UV		432V ac	± 5.0V ac	± 5.0V ac
<u>2</u> Delay		Minimum	Same as Standard	< 0.7 sec
(b) Diversified Electronics 27 Source Selector Relays left and right (120V dc)				
UV		107V dc	Same as standard	± 1V dc
(c) Interlock delay				
ir/x-5.....		Minimum	Same as standard	Same as standard
(5) MCC transfer control relays				
(a) Diversified Electronics 27/47				
<u>1</u> UV		432V ac	± 5.0V ac	± 5.0V ac
<u>2</u> Delay		Minimum	Same as Standard	< 0.7 sec
(b) Diversified Electronics 27 Source Selector Relays left and right (120V dc)				
UV		107V dc	Same as standard	± 1V dc
(c) Interlock delay				
ir/x-5.....		Minimum	Same as standard	Same as standard

Standards and Tolerances (Continued)

Parameter	Reference Paragraph	Standard	Tolerance/Limit	
			Initial	Operating
(6) CDP transfer control relays				
(a) Diversified Electronics 27/47 (208V ac)				
<u>1</u> UV		187V ac	± 5.0V ac	± 5.0V ac
<u>2</u> Delay		Minimum	Same as Standard	< 0.7 sec
(b) Diversified Electronics 27 Source Selector Relays left and right (120V dc)				
UV		107V dc	Same as standard	± 1V dc
(c) Interlock delay				
ir/x-5		5 sec	Same as standard	Same as standard
(d) Crompton 25 (Sync check 120V Relay)				
<u>1</u> Voltage		10%	Same as standard	Same as standard
<u>2</u> Phase Angle		6 electrical degrees	Same as standard	Same as standard
306. DRPDS Circuit Breaker.....		baseline	Same as standard	Same as standard
Settings				
307. Power Distribution Units (PDUs)				
a. PDU (general)				
(1) Rated output power		75 kVA	Same as standard	Same as standard
(2) Rated output voltage		208Y/120Vac, 3 Phase, 60 Hz, 4 wire	Same as standard	Same as standard
(3) Harmonic filter contactor pickup.....		Minimum setting	Same as standard	Same as standard
(4) Harmonic Voltage Content	FAA-G-2100G	5% THD	Same as standard	Same as standard

Standards and Tolerances (Continued)

<i>Parameter</i>	<i>Reference Paragraph</i>	<i>Standard</i>	<i>Tolerance/Limit</i>	
			<i>Initial</i>	<i>Operating</i>
b. M4 alarms				
(1) High temperature alarm		374° F (190° C)	Same as standard	Same as standard
(2) High temperature shutdown.....		428° F (220° C)	Same as standard	Same as standard
(3) Input volts high alarm		528V ac phase to phase	Same as standard	Same as standard
(4) Input volts low alarm		288V ac phase to phase	Same as standard	Same as standard
(5) Output volts high alarm		228.8V ac phase to phase	Same as standard	Same as standard
(6) Output volts low alarm		187.2V ac phase to phase	Same as standard	Same as standard
(7) Output volts high alarm		132V ac phase to neutral	Same as standard	Same as standard
(8) Output volts low alarm		108V ac phase to neutral	Same as standard	Same as standard
(9) Output amps high alarm.....		225 amps per phase	Same as standard	Same as standard
(10) Output amps low alarm.....		0 amps	Same as standard	Same as standard
(11) Output ground amps high alarm		200 amps	Same as standard	Same as standard
(12) Output ground amps low alarm		0A	Same as standard	Same as standard
(13) Output kVA high alarm		27 kVA	Same as standard	Same as standard
(14) Output kVA low alarm		0 kVA	Same as standard	Same as standard
(15) Output KW high alarm		Not used		
(16) Output KW low alarm		0 KW	Same as standard	Same as standard
(17) Output PF high alarm.....		Not used		

Standards and Tolerances

Parameter	Reference Paragraph	Standard	Tolerance/Limit	
			Initial	Operating
(18) Output PF low alarm.....		Not Used		
(19) Output THD high alarm.....		Not used		
(20) Output THD low alarm.....		Not used		
(21) Line frequency high alarm.....		61 Hz	Same as standard	Same as standard
(22) Line frequency low alarm.....		59 Hz	Same as standard	Same as standard
(23) Neutral current high alarm.....		225 amps	Same as standard	Same as standard
(24) Total kVA high alarm.....		83 kVA	Same as standard	Same as standard
* 308. L3 Static Transfer Switches (STS) 150-600 AMPS	L3 Technical Manual for Static Transfer Switch 150-600 AMPS		Same as standard	Same as standard
a. Voltage Output (L-N)	530	120 V	±12V	±12V
b. Output Frequency.....	530	60 Hz	±1.2 Hz	±1.2 Hz
c. Switching Time Between Sources..... In-Phase Transfers ≤ 15° Difference)	Appendix 1	≤4.2 ms	Same as standard	Same as standard
d. Set-point Control.				
(1) Max Phase Error (degrees) for Controlled Transfer.		15	Same as standard	Same as standard
(2) Over-voltage (L-N)		132V	Same as standard	Same as standard
(3) Under-voltage 10 (L-N)		108V	Same as standard	Same as standard
(4) Peak Overload (Amps)			Same as standard	Same as standard
150A unit.....		530		
600A unit.....		2118		
(5) Retransfer Time Delay seconds) ..		15	Same as standard	Same as standard *

Standards and Tolerances

<i>Parameter</i>	<i>Reference Paragraph</i>	<i>Standard</i>	<i>Tolerance/Limit</i>	
			<i>Initial</i>	<i>Operating</i>
* (6) Toggle Retransfer On/Off		Off	Same as standard	Same as standard
(7) Toggle Preferred Source.....		Site Specific (1 or 2)	Same as standard	Same as standard
(8) Delayed Transfer (milliseconds) ..		0	Same as standard	Same as standard *
309. PMCS			Same as standard	Same as standard
a. Software Configuration.....	TI 6480.1 volume 9 section 1.7	Baseline		
(1) Monitor Pro				
(a) Program Version				
<u>1</u> A80, HCF, NCT.....		2.0		
<u>2</u> PCT		2.1	Same as standard	Same as standard
(b) Program Configuration.....		Run-time	Same as standard	Same as standard
(c) Application Revision			Same as standard	Same as standard
<u>1</u> A80.....		12/22/00		
<u>2</u> HCF.....		12/05/00	Same as standard	Same as standard
<u>3</u> NCT.....		1/29/01	Same as standard	Same as standard
<u>4</u> PCT		4/11/02	Same as standard	Same as standard
(2) Concept			Same as standard	Same as standard
(a) Program Version				
<u>1</u> HCF, NCT Main, PSG and EG PLCs..		2.1, B2.1XL	Same as standard	Same as standard
<u>2</u> A80				
<u>a</u> Main PLC.....		2.2, XL SR2		
<u>b</u> PSG and EG PLC		2.1, B2.1XL	Same as standard	Same as standard
<u>3</u> PCT			Same as standard	Same as standard
<u>a</u> Main and PSG PLC		2.2, XL SR2		

Standards and Tolerances

<i>Parameter</i>	<i>Reference Paragraph</i>	<i>Standard</i>	<i>Tolerance/Limit</i>	
			<i>Initial</i>	<i>Operating</i>
<u>b</u> EG PLC.....		2.1, B2.1XL	Same as standard	Same as standard
* <u>c</u> PSG and EG PLC		2.1, B2.1XL		*
(b) Program Configuration.....		Read only	Same as standard	Same as standard
(c) Application Revision			Same as standard	Same as standard
<u>1</u> A80.....		12/22/00	Same as standard	Same as standard
<u>2</u> HCF.....		12/05/00	Same as standard	Same as standard
<u>3</u> NCT		1/29/01	Same as standard	Same as standard
<u>4</u> PCT		4/11/02	Same as standard	Same as standard
(3) SMS				
(a) Program Version.....				
<u>1</u> A80, HCF, NC.....		3.02a	Same as standard	Same as standard
<u>2</u> PCT		3.1	Same as standard	Same as standard
(b) Program Configuration.....				
(c) Application Revision				
<u>1.</u> A80.....		12/22/00	Same as standard	Same as standard
<u>2.</u> HCF.....		12/05/00	Same as standard	Same as standard
<u>3.</u> NCT		1/29/01	Same as standard	Same as standard
<u>4.</u> PCT.....		4/11/02	Same as standard	Same as standard
b. Hardware Configuration.....	TI 6480.1 volume 9	In accordance with TI 6480.1	Same as standard	Same as standard
c. Timing Sequences	TI 6480.1 volume 1	In accordance with TI 6480.1	Same as standard	Same as standard

Standards and Tolerances (Continued)

<i>Parameter</i>	<i>Reference Paragraph</i>	<i>Standard</i>	<i>Tolerance/Limit</i>	
			<i>Initial</i>	<i>Operating</i>
310. Electrical Power Raceways				
a. Cable Insulation (600V or less)				
(1) New Cable.....	JO 6950.22	30 Mohms minimum at 500V dc	Same as standard	Same as standard
(2) Old Cable		10 Mohms minimum at 500V dc	Same as standard	2 Mohms minimum at 500V dc
b. Busway Insulation.....	TI 6480.1 volume 2 1 line Indoor Feeder Busway Instruction Bulletin	1 Mohm per 100 feet of busway	Same as standard	Same as standard
311. – 399. Reserved				

Standards and Tolerances (Continued)

<i>Parameter</i>	<i>Reference Paragraph</i>	<i>Standard</i>	<i>Tolerance/Limit</i>	
			<i>Initial</i>	<i>Operating</i>
<u>b</u> EG PLC.....		2.1, B2.1XL	Same as standard	Same as standard
(b) Program Configuration.....		Read only	Same as standard	Same as standard
(c) Application Revision				
<u>1</u> A80.....		12/22/00	Same as standard	Same as standard
<u>2</u> HCF.....		12/05/00	Same as standard	Same as standard
<u>3</u> NCT.....		1/29/01	Same as standard	Same as standard
<u>4</u> PCT.....		4/11/02	Same as standard	Same as Standard
(3) SMS				
(a) Program Version				
<u>1</u> A80, HCF, NCT.....		3.02a	Same as standard	Same as standard
<u>2</u> PCT.....		3.1	Same as standard	Same as standard
(b) Program Configuration				
(c) Application Revision				
<u>1</u> A80.....		12/22/00	Same as standard	Same as standard
<u>2</u> HCF.....		12/05/00	Same as standard	Same as standard
<u>3</u> NCT.....		1/29/01	Same as standard	Same as standard
<u>4</u> PCT.....		4/11/02	Same as standard	Same as standard
b. Hardware Configuration.....	TI 6480.1 volume 9	In accordance with TI 6480.1	Same as standard	Same as standard
c. Timing Sequences	TI 6480.1 volume 1	In accordance with TI 6480.1	Same as standard	Same as standard

Standards and Tolerances (Continued)

<i>Parameter</i>	<i>Reference Paragraph</i>	<i>Standard</i>	<i>Tolerance/Limit</i>	
			<i>Initial</i>	<i>Operating</i>
310. Electrical Power Raceways				
a. Cable Insulation (600V or less)				
(1) New Cable	JO 6950.22	30 Mohms minimum at 500V dc	Same as standard	Same as standard
(2) Old Cable		10 Mohms minimum at 500V dc	Same as standard	2 Mohms minimum at 500V dc
b. Busway Insulation	TI 6480.1 volume 2 1 line Indoor Feeder Busway Instruction Bulletin	1 Mohm per 100 feet of busway	Same as standard	Same as standard
311. – 399. Reserved.				

Chapter 4. Periodic Maintenance

400. General.

a. Organization. This chapter establishes periodic maintenance activities and schedules for DRPDS electrical systems. This chapter has two sections. The first section identifies the performance checks (for example: tests, measurements, and observations) of normal operating controls and functions necessary to ensure operation within established tolerances or limits. The second section identifies other tasks necessary to prevent deterioration or ensure reliable operation. Refer to Order 6000.15, General Maintenance Handbook for Airway Facilities, for additional general guidance.

b. Accomplishment of Scheduled Activities. Periodic maintenance activities and frequencies of performance apply specifically to requirements for DRPDS electrical systems preventive maintenance. Personnel assigned responsibility for maintenance shall ensure that all tasks prescribed are accomplished no less frequently than the intervals specified. Performance of applicable periodic maintenance activities as often or more often than that specified satisfies the requirement for task accomplishment. The requirements represent the minimum tasks and maximum intervals for performance and do not preclude performance or additional tasks considered desirable by the responsible maintenance organization.

c. Relationship to Other Publications. All required periodic maintenance activities applicable to preventive maintenance of DRPDS electrical systems appear herein. The schedules supersede those published in all other handbooks and the equipment instruction books for this facility. Chapter 4, paragraph 401 lists various reference publications containing technical information and agency-oriented maintenance policy, criteria, guidelines, and procedures, much of which are generally useful and applicable to maintenance of DRPDS electrical systems. Personnel shall apply these referenced handbooks as required to supplement this handbook and the applicable equipment instruction book. In the case of conflict, this handbook shall take precedence.

401. References. Entries in the reference column of section 1 and section 2 refer to TI 6480.1, to this handbook. The TI 6480.1 consists of 9 separate volumes. Volumes 1 through 9 are listed in the reference columns as TI 6480.1. References to TI 6480.1 are identified by volume and in some cases section number or vendor publication title. Order references are identified by an Appendix number and in some cases a paragraph number. Unless otherwise indicated, references apply to the books and orders listed below.

- a. TI 6480.1, Critical Power Distribution System (CPDS), Volume 1, System Overview.
- b. TI 6480.1, Critical Power Distribution System (CPDS), Volume 2, Switchgear.
- c. TI 6480.1, Critical Power Distribution System (CPDS), Volume 3, EGs.
- d. TI 6480.1, Critical Power Distribution System (CPDS), Volume 4, EG Controls.
- e. TI 6480.1, Critical Power Distribution System (CPDS), Volume 5, Switchboards and MCCs.

- f.** TI 6480.1, Critical Power Distribution System (CPDS), Volume 6, UPS).
- g.** TI 6480.1, Critical Power Distribution System (CPDS), Volume 7, SATS and PDU
- h.** TI 6480.1, Critical Power Distribution System (CPDS), Volume 8, Miscellaneous Equipment.
- i.** TI 6480.1, Critical Power Distribution System (CPDS), Volume 9, PMCS.
- j.** Order 6000.15, General Maintenance Handbook for Airway Facilities.
- k.** Order JO 6950.17, Maintenance of Electrical Systems in Buildings.
- l.** Order JO 6950.18, Maintenance of Electrical Distribution Systems.
- m.** Order JO 6980.11, Maintenance of Engine Generators.
- n.** Order JO 6980.25, Maintenance of Batteries for Standby Power.
- o.** Order 3900.19, .FAA Occupation Safety and Health Program.
- p.** Order JO 6950.22, Maintenance of Electrical Power and Control Cables.
- q.** FAA-G-2100, Electrical Equipment, General Requirements.

Section 1. Performance Checks

<i>Performance Checks</i>	<i>Reference Paragraph</i>	
	<i>Standards & Tolerances</i>	<i>Maintenance Procedures</i>
402. Every 2 Hours.		
2 Hour Performance Checks While Operating on Stand By Power.	214	503
403. Every 8 Hours.		
a. 8 Hour Performance Checks While Operating on Stand By Power.	214	504
b. 8 Hour Performance Checks While Operating on Commercial Power	208	505
404. Daily.		
* a. Engine Generator.		
Daily fuel filtration.....	302a(4)(a)8	506
b. STS		
Verify proper STS operation is indicated on each STS front control panel.	308(f – i)	530
405. Weekly (Reserved).		
406. Monthly.		
a. Commercial Transformers Preventive Maintenance¹.....	301	507
b. UPS Monthly Performance Checks	303f	508
c. Engine Generator Monthly Performance Checks	302a(2)	509
d. Transient Voltage Surge Suppressor (TVSS) Monthly Performance Checks.		510
e. Control and Interrogation Power Systems	304	
(1) DC System Monthly Transfer Switch Operation.....		511
(2) AC System Monthly Transfer Switch Operation		
407. Quarterly.		
a. PMCS Quarterly performance checks.....	309	512
b. Control and Interrogation Power Systems.....	304a(1)a	513

¹Maintenance to commercial transformers shall be performed by the local utility company at their discretion.

Section 1. Performance Checks (Continued)

<i>Performance Checks</i>	<i>Reference Paragraph</i>	
	<i>Standards & Tolerances</i>	<i>Maintenance Procedures</i>
c. UPS Note: When Performance Checks coincide with Preventive Maintenance Checks, perform ONLY the preventive maintenance checks (1) Powerware 9315/BPIII 30-160 Performance Checks (2) Powerware 9315/BPIII 180-500 Performance Checks (3) VRLA battery resistance measurements	303 303 303 303f	TI 6480.1 volume 6 TI 6480.1 volume 6 part 1, book 1 section 7.14 TI 6480.1 volume 6 part 2, book 1 section 7.20 TI 6480.1 volume 6 part 3, book 1 tab 9& volume 8 part 1, book 3 tab 1, 2 and 3
408. Semiannually. a. PMCS. Semi-Annual Utility Outage Test	309c 303g 302a,b	514
b. UPS. (1) Perform Preventive Maintenance Procedures	303a	TI 6480.1 volume 6 part 2, book 1 tab 1 section 7.20 * TI 6480.1 volume 6 part 1, book 1 tab 1 section 7.14 *

Section 1. Performance Checks (Continued)

<i>Performance Checks</i>	<i>Reference Paragraph</i>	
	<i>Standards & Tolerances</i>	<i>Maintenance Procedures</i>
(2) Perform One-Time Delayed Battery Bank Test (@ > 50% rated UPS load)	303f	TI 6480.1 volume 6 part 2, book 1 sections 5.9 and 7.14.8.9
* Note: Spot check battery cell (negative) post and cable..... temperatures with infrared gun. Verify that no individual cell or cable temperatures are radically higher than average.		TI 6480.1 volume 6 part 1, book 1 sections 5.3.14 and 7.11.8.9 part 3, book 1 tab 10
* Record cell # for any DC Tracker low cell shutdown voltage alarm	303g	*
409. Annually.		
a. Engine Generators.		
(1) Engine Generator Step Load Test	302b(1)	515
(2) EG 2 hour run		
(a) Coolant temperature (outlet).....	302a(2)	
(b) Lubrication oil pressure	302a(6)	
(c) Lubrication oil temperature	302a(6)	
(d) Output frequency	302b(3)	
(e) Output kilowatts.....	302b(1)	
(f) Output voltage.....	302b(4)	
(g) Engine Fuel System Operation.....	302a(4)	
(h) Engine Exhaust for Evidence of Incomplete Fuel	302a(3)	
Combustion		
(i) Radiator Fan Operation.		
(j) Engine Fuel System Main Tank Operation.....	302a(4)	

Section 1. Performance Checks (Continued)

<i>Performance Checks</i>	<i>Reference Paragraph</i>	
	<i>Standards & Tolerances</i>	<i>Maintenance Procedures</i>
(3) Engine Warning/Shutdown Performance Checks.		
(a) EG High Temperature Warning and Shutdown Test.....	302(c)(1)(f)	516
(b) EG Low Oil Pressure Warning and Shutdown Test	302(c)(1)(e)	517
(c) EG Low Fuel level Warning Test.....		518
(d) EG Over-Crank Test.....	302(c)(1)(g)	519
(e) EG Low Coolant Level Shutdown Test		520
(f) EG NOT-IN-AUTO Lamp TEST		521
(g) EG Emergency Stop Test		522
(h) EG Over-Voltage Shutdown Test.....	302(c)(1)(b)	523
(i) EG Under-voltage Shutdown Test	302(c)(1)(c)	524
(j) EG Under-Frequency Shutdown Test	302(c)(1)(d)	525
(k) EG Over-Frequency Shutdown Test		526
(l) EG Low Battery Voltage Test	302(c)(2)(b)	527
(m) EG High Battery Voltage Test	302(c)(2)(c)	528
b. Control and Interrogation Power Systems		
(1) Control System Battery and Charger.		
(a) Float and High Rate Voltage Settings Checks	304a	TI 6480.1 volume 8, part 1, book 1, tab 1, section 6.0
(b) Battery State of Charge Verification by Initiating High Rate Charge.	304a	TI 6480.1 volume 8, part 1, book 1, tab 1, section 4.1
(2) Interrogation system ASCO 940 and 7000 transfer switches.		
(a) Automatic Transfer Test (UV) For Control and		529
Interrogation Power Systems		

Section 1. Performance Checks (Continued)

<i>Performance Checks</i>	<i>Reference Paragraph</i>	
	<i>Standards & Tolerances</i>	<i>Maintenance Procedures</i>
(b) Verify transfer set point	304(b)(1 and 2)	529
(3) Control System ASCO 962 and 7000 transfer switches.		
(a) Automatic Transfer Test (UV) For Control and Interrogation Power Systems		
(b) Verify transfer set point	304(a)(3 and 4)	
c. PMCS.		
(1) Perform a manual Hot Standby switchover	309a	TI 6480.1 volume 9
(2) Verify that all PMCS CPU Battery Low Indicators are not active.	309a	TI 6480.1 volume 9
(3) Verify PMCS software configuration	309a	TI 6480.1 volume 9
* d. STS. (see 6000.15E paragraph 321(c). Place STS in maintenance... and perform the following:		
(1) Perform an infrared scan of the STS power connections		531d(1)
(2) Perform transfers		532 or 533
(3) Shut unit down, pull and inspect fuses, and perform A thorough visual inspection of the entire unit.		531d(2)
e. PDUs.		
(1) Measure/record total harmonic distortion (THD) for each phase voltage, current, and neutral conductor at the each PDU output.	307a	TI 6480.1 volume 7
(2) Measure and record THD at critical bus	307a	
410. Triennially.		
a. Distribution Equipment Protective and Control Relays.....	305a(1) and (2)	TI 6480.1 Volume 1
(1) SWGR OV and UV relays	305a(3) and (4)	
(2) SWBD UV and OV	305a(5)	
(3) MCC UV	305a(6)	
(4) CDP UV and sync check relays	305a(3) and (4)	
(5) PSG UV, UF and sync check relays	302c(5)	TI 6480.1 volume 8

*

Section 1. Performance Checks (Continued)

<i>Performance Checks</i>	<i>Reference Paragraph</i>	
	<i>Standards & Tolerances</i>	<i>Maintenance Procedures</i>
(a) Beckwith Engine Generator Protection Relays	302c(4)	TI 6480.1 volume 8
<u>1</u> 24 device		
<u>2</u> 32 device		
<u>3</u> 40 device		
<u>4</u> 59 device		
<u>5</u> 27 device		
<u>6</u> 46 device		
<u>7</u> 87 device		
<u>8</u> 81 device		
<u>9</u> 60FL device		
411. – 435. Reserved.		

Section 2. Other Maintenance Tasks

<i>Maintenance Tasks</i>	<i>Reference Paragraph</i>	
	<i>Standards & Tolerances</i>	<i>Maintenance Procedures</i>
436. Weekly.		
a. Diesel Engine Generator Area.		
(1) Check diesel engine lubrication oil level; add if necessary	302a	TI 6480.1 volume 3
(2) Check diesel engine coolant level; add as required		
(3) Check all hoses and piping for condition and visual sign of air, fuel, or water leaks. Clean up spills and repair leaks as necessary		
(4) Drain condensate from fuel oil day tanks		
(5) Visually check all drive belts for deterioration; correct as necessary		
b. Outside Area.		
(1) Load bank: check to ensure that objects have not blocked or entered the intake and exhaust openings or that obstructions are not diverting or restricting air flow to the load bank		TI 6480.1 volume 8
(2) Radiators: Check for obstructions to intake and exhaust openings		TI 6480.1 volume 3
437. Monthly.		
a. Radiator Inspection.		
Inspect radiator flexible couplings, belts, gear reducers, and fan shaft for condition	302a	
b. Fuel Storage.		
Determine fuel level in above ground storage tanks. Record level. Order additional fuel if level is low		
c. UPS VRLA Batteries.		
Inspect connections for tightness, cleanliness, leaks, and evidence of corrosion; remove dirt and tighten connections as required	JO 6980.25, ch 3	TI 6480.1 volume 6

Section 2. Other Maintenance Tasks (Continued)

<i>Maintenance Tasks</i>	<i>Reference Paragraph</i>	
	<i>Standards & Tolerances</i>	<i>Maintenance Procedures</i>
<p>d. DC Control System NiCd Batteries</p> <p style="padding-left: 40px;">NOTE: Inspect connections for tightness, cleanliness, evidence of leaks, and evidence of corrosion; remove dirt and tighten connections as required check electrolyte level.</p>	JO 6980.25, chapter 3	TI 6480.1 volume 8
<p>e. EG DC Start System Batteries.</p> <p style="padding-left: 40px;">Check battery electrolyte specific gravity</p>		TI 6480.1 volume 3
<p>438. Quarterly – Reserved.</p>		
<p>439. Semiannually.</p>		
<p>a. Loadbank.</p> <p style="padding-left: 40px;">(1) Clean dirt and debris from interior of load bank using clean dry Compressed air.</p> <p style="padding-left: 40px;">(2) Inspect resistor elements for mechanical breakdown; replace with new resistor elements</p> <p style="padding-left: 40px;">(2) Inspect for broken ceramic insulators; replace any broken or cracked Insulators</p> <p style="padding-left: 40px;">(4) Inspect for loose connections or hardware; tighten where required</p> <p style="padding-left: 40px;">(5) Inspect for signs of wire insulation failure; replace where required</p> <p style="padding-left: 40px;">(6) Inspect all magnetic contractors for corrosion or pitting and replace as necessary</p> <p style="padding-left: 40px;">(7) Verify AIRFLOW switch works properly</p> <p style="padding-left: 40px;">(8) Verify indicator lamps work properly</p>		TI 6480.1 volume 8 part 1, book 1
<p>b. Commercial Transformers</p> <p style="padding-left: 40px;">Check oil filled transformers for visible leaks; report to utility.</p>	JO 6950.18 chapter 3	JO 6950.18, chapter 4
<p>440. Annually.</p>		
<p>a. Diesel Engine Generators.</p>		TI 6480.1 volume 3

Section 2. Other Maintenance Tasks (Continued)

<i>Maintenance Tasks</i>	<i>Reference Paragraph</i>	
	<i>Standards & Tolerances</i>	<i>Maintenance Procedures</i>
(1) Blow dust and dirt out of generator and exciter assemblies using 20 to 30 psig of dry air. (2) Check vibrator isolators; replace if required. (3) Drain and clean or replace fuel oil filters and strainers, and sample fuel. (4) Lubricate generator bearings. (5) Inspect muffler repair as required. (6) Inspect turbocharger operation. Check for intake or exhaust leaks, check inlet and outlet oil lines for leaks or restrictions, and observe unusual noise or vibration; troubleshoot and repair as required. (7) Change/Clean air cleaner.		TI 6480.1 volume 3
b. Diesel Engine Radiators. (1) Check antifreeze strength by chemical analysis; add/change antifreeze or add corrosion inhibitor as required to attain correct protection. (2) Check for obstructions to free air circulation, signs of leaks. Correct as necessary. (3) Check operating temperature of fan bearings; lubricate as required.		TI 6480.1 volume 3
c. Electrical Manholes. (1) Check waterproof seal. (2) Examine cables for signs of damage. (3) Pump out accumulated water and remove debris.		
d. Load Bank and Controls. Lubricate blower motor		TI 6480.1 volume 8 part 1, book 1 tab 15

Section 2. Other Maintenance Tasks (Continued)

<i>Maintenance Tasks</i>	<i>Reference Paragraph</i>	
	<i>Standards & Tolerances</i>	<i>Maintenance Procedures</i>
e. SWGR.		
(1) Buses and Connections.....		TI 6480.1 volume 2 part 1, book 1 tab 2
(2) Instruments		
(3) Control Wiring		
(4) Mechanical Parts		
(5) Ventilation		
(6) Records		
(7) Abnormal Conditions		
(8) Metal Surfaces		
(9) Breaker Main Connectors		
(10) Traveling Lifter Assembly		TI 6480.1 volume 2 part 1, book 1 tab 3
f. SWGR Circuit Breakers (type DS).....		TI 6480.1 volume 2 tab 6 tab 4
NOTE: Circuit breaker maintenance should be performed annually and when the number of breaker operations exceeds manufacture limits. In addition, maintenance should be performed any time a breaker operates to clear a fault.		
(1) Operate circuit breakers in remote mode.....		TI 6480.1 volume 9
(2) Operate circuit breakers electrically and manually in local mode		TI 6480.1 volume 2
(3) Verify breaker settings		TI 6480.1 volume 1
(4) Check digitrip battery		TI 6480.1 volume 2

Section 2. Other Maintenance Tasks (Continued)

<i>Maintenance Tasks</i>	<i>Reference Paragraph</i>	
	<i>Standards & Tolerances</i>	<i>Maintenance Procedures</i>
(5) Arc Chute.....		TI 6480.1 volume 2
(6) Breaker Contacts		
(7) General Inspection		
(8) Lubrication		
* g. MCCs and CDPs.		*
(1) Enclosure		TI 6480.1 volume 5 part 1, book 1 tab 1
(2) Bus Bars and Incoming Line Compartments		
(3) Control Unit		
(4) Tests and maintenance performed with Control Unit removed		
(5) Insulation Tests		
h. MCC and CDP circuit breakers (type NSJ).		
(1) Inspection of terminals		volume 5 tab 4
(2) Cleaning		
(3) Mechanical		
(4) Setting		TI 6480.1 volume 1
(5) Perform secondary injection test.....		TI 6480.1 volume 8
i. CDP circuit breakers (type LE).		
(1) Setting		TI 6480.1 volume 1

Section 2. Other Maintenance Tasks (Continued)

<i>Maintenance Tasks</i>	<i>Reference Paragraph</i>	
	<i>Standards & Tolerances</i>	<i>Maintenance Procedures</i>
(2) Overheating, energized and de-energized.....		TI 6480.1 volume 5
(3) Molded case inspection		volume 5 part 1, book 1 tab 9
(4) Exercise circuit breaker mechanism		
(5) Circuit breaker cleaning		
(6) Enclosure inspection		
(7) Perform secondary injection test.....		volume 8, part 1, book 3 tab 18
j. SWBDs.		
(1) General Inspection and Cleaning		volume 5 part 1, book 1 tab 23
(2) Bus Bar Joints Lug Terminations and Insulating Materials		
(3) General Lubrication		
k. SWBD circuit breakers (type CK).		
(1) Inspection.....		volume 8 part 1, book 1 tab 31
(2) Cleaning		
(3) Mechanical Checks		
(4) Setting		volume 1 part 2, book 1-4
(5) Perform secondary injection test		
l. SWBD circuit breakers (type ME).		
(1) Setting		TI 6480.1 volume 1 appendix D

Section 2. Other Maintenance Tasks (Continued)

<i>Maintenance Tasks</i>	<i>Reference Paragraph</i>	
	<i>Standards & Tolerances</i>	<i>Maintenance Procedures</i>
(2) Overheating, energized and de-energized.....		TI 6480.1 volume 5 part 1, book 1 tab 9
(3) Molded case inspection		
(4) Exercise circuit breaker mechanism		
(5) Circuit breaker cleaning		
(6) Enclosure inspection		
(7) Perform secondary injection test		
m. SATS.		
Isolate the unit under test from the critical load and perform the following.		TI 6480.1 volume 7
(a) Cleanliness		
(b) Mechanical Parts		
(c) Connections		
* (d) Verify metering accuracy		*
n. PDUs.		
Isolate the unit under test from the critical load and perform the following		TI 6480.1 volume 7
(a) EPO check		
(b) Inspect and clean		
(c) Cycle Molded case switches		
(d) Verify M4 meter accuracy		
o. Electrical Power Raceways.		
(1) Inspect busway at load using an infrared gun or camera.....		TI 6480.1 volume 2 and 5
(2) Inspect electrical power cable terminations at load using an infrared gun or camera		

Section 2. Other Maintenance Tasks (Continued)

<i>Maintenance Tasks</i>	<i>Reference Paragraph</i>	
	<i>Standards & Tolerances</i>	<i>Maintenance Procedures</i>
(c) Operate DC control system circuit breakers.....		TI 6480.1 volume 8
(2) Inspect AC Interrogation system connections for overheating and tighten as required. Use infrared scanner for detection of loose connections or overheating.		
(a) Inspect and clean transfer switch.....		TI 6480.1 volume 8
(b) Operate transfer switch		
(c) Operate AC control system circuit breakers		
d. Busway and Power Cables.		
Perform insulation megger tests on raceway power cables and busway		
442. Every 3 Years.		
a. Distribution and Lighting Panels		JO 6950.17
Check molded case circuit breakers in all distribution and lighting panels for loose or burned connections and operate each breaker.		
b. Dry Type Transformers		JO 6950.18 TI 6480.1 volume 8
Remove cover and inspect each transformer for signs of overheating or abnormal conditions.		
c. PMCS	chapter 3	TI 6480.1 volume 2
Verify meter calibration and calibrate as necessary.....		TI 6480.1 volume 1
* d. SWGR Circuit Breakers (type DS)		
Perform primary injection to verify DS circuit breaker over-current operation with AVO/Multi-Amp CB Test Set Model DDA-3000/6000 universal circuit breaker test set		TI 6480.1 volume 8 part 1, book 1 tab 17 *
443. Every 5 Years.		
a. Generators and Exciters.		
(1) Measure and record insulation resistance of generators and exciters		TI 6480.1 volume 3
(2) Replace radiator rubber hoses, belts and starting system batteries		
444. – 499. Reserved.		

Chapter 5. Maintenance Procedures

500. Purpose or Function. This chapter establishes the procedures for accomplishing the various essential maintenance activities required for the Dual Redundant Power Distribution System (DRPDS) electrical systems, on either a periodic or incidental basis. The chapter has three sections. The first section describes the procedures for the performance checks listed in chapter 4, section 1 of this handbook. The second section describes the procedures for doing the tasks listed in chapter 4, section 2 of this handbook. The third section describes the procedures for doing special tasks, usually nonscheduled and not listed in chapter 4 of this handbook. Refer to Order 6000.15, General Maintenance Handbook for National Airspace System (NAS) Facilities for additional general guidance.

WARNING: Never work alone while performing maintenance on or troubleshooting DRPDS equipment. High voltage and energy levels are present on much of the DRPDS equipment and extreme caution must always be exercised. Use local lockout/tagout procedures when energizing, startup, or release of energy can occur. This is necessary to make sure that other personnel cannot start the power source during maintenance. Shock hazards can kill. Such procedures are a requirement from the latest version of Order 3900.19, FAA Occupational Safety and Health.

Section 1. Performance Check Procedures

501. General. The Terminal Radar Approach Control Facility (TRACON) DRPDS electrical system has indicators and monitors for measuring system performance. By conducting the performance checks contained in chapter 4, section 1 of this handbook, a determination is made of proper system operation. The performance checks are conducted by observing specific system performance parameters during normal operation or by performing special procedures defined in this section. Whenever the observed parameters are not within the operating tolerances or limits specified, corrective action shall be taken.

502. . FAA Technical Performance Record (TPR) Entries. Order 6000.15 contains policy, guidance and detailed instructions for field use of FAA Technical Performance Record forms. Entries * shall be in accordance with the instructions published in Order 6000.15. TPR forms are available at https://employees.faa.gov/tools_resources/forms/.

503. 2 Hour Performance Checks While Operating on Standby Power. *

a. Object. These procedures establish guidelines for performance checks for the operation of the Power Monitoring and Control System (PMCS), Paralleling Switchgear (PSG), Engine Generators (EGs), and EG Auxiliary equipment of the DRPDS system while on stand by power.

b. Discussion. Prior to conducting any preventive maintenance, ensure that risk assessment and mitigation has been conducted in accordance with paragraph 104 of this handbook, additionally, all work that could impact air traffic should be coordinated with air traffic control (ATC). During operation of the DRPDS system on stand by power, it is critical to perform 2 hour performance checks on the PMCS, PSG, EGs, and EG auxiliary equipment to ensure proper configuration and operation of the system.

c. Conditions. DRPDS system operating on stand by power in accordance with paragraph 214 of this handbook.

d. Detailed Procedures.

(1) Verify proper operation and configuration of the PMCS as described in paragraph 214a of this handbook. For more information on the PMCS, refer to Critical Power Distribution System (CPDS) TI 6480.1, volume 9.

(2) Verify proper operation and configuration of the PSG as described in paragraph 214c of this handbook. For more information on the PSG, refer to TI 6480.1, volume 4.

(3) Verify proper operation and configuration of the EGs as described in paragraph 214d of this handbook. Also verify that the parameters listed in chapter 4, paragraph 409a(2) are within the given tolerances for operating EGs. For more information on the EGs, refer to TI 6480.1 volume 3.

(4) Verify proper operation and configuration of the EG auxiliary equipment as described in paragraph 214e of this handbook. For more information on the EG auxiliary equipment, refer to TI 6480.1 volume 3.

504. 8 Hour Performance Checks While Operating on Standby Power.

a. Object. These procedures establish guidelines for performance checks for the operation of Switchgear (SWGR) 1 & 2, Switchboard (SWBD) 1 & 2, Motor Control Center (MCC), UPS SWGR, the Uninterruptible Power Systems (UPSs), the UPS Output SWBDs, Critical Buses, Power Distribution Units (PDUs), Static Automatic Transfer Switches (SATS), Critical Distribution Panels (CDPs), and the Control and Interrogation Power Systems of the DRPDS system while on stand by power.

b. Discussion. Prior to conducting any preventive maintenance, ensure that risk assessment and mitigation has been conducted in accordance with paragraph 104 of this handbook, additionally, all work that could impact air traffic should be coordinated with ATC. During operation of the DRPDS system on stand by power, it is critical to perform 8 hour performance checks on SWGR 1, SWGR 2, SWBD 1, SWBD 2, the MCCs, the UPS SWGR, the UPSs, the UPS Output SWBDs, the Critical Buses, the PDUs, the SATS, the CDPs and the Control and Interrogation Power Systems in order to ensure proper operation and configuration of the DRPDS system while operating on stand by power.

c. Conditions. DRPDS system operating on stand by power in accordance with paragraph 214 of this handbook.

d. Detailed Procedures.

(1) Verify proper operation and configuration of SWGR 1 and SWGR 2 as described in paragraph 214b of this handbook. For more information on SWGR 1 and SWGR 2, refer to

TI 6480.1 volume 2.

- (2) Verify proper operation and configuration of SWBD 1 and SWBD 2 as described in paragraph 214f of this handbook. For more information on SWBD 1 and SWBD 2, refer to TI 6480.1 volume 2.
- (3) Verify proper operation and configuration of the MCCs as described in paragraph 214g of this handbook. For more information on the MCCs, refer to TI 6480.1 volume 5.
- (4) Verify proper operation and configuration of the UPS SWGR as described in paragraph 214h of this handbook. For more information on the UPS SWGR, refer to TI 6480.1 volume 2.
- (5) Verify proper operation and configuration of the UPSs as described in paragraph 214i of this handbook. For more information on the UPSs, refer to TI 6480.1 volume 6.
- (6) Verify proper operation and configuration of the UPS Output Switchboards as described in paragraph 214j of this handbook. For more information on the UPS Output Switchboards, refer to TI 6480.1 volume 5.
- (7) Verify proper configuration of the Critical Buses as described in paragraph 214k of this handbook. For more information on the critical buses, refer to TI 6480.1 volume 8.
- (8) Verify proper configuration of the PDUs as described in paragraph 214l of this handbook. For more information on the PDUs, refer to TI 6480.1 volume 7.
- (9) Verify proper operation and configuration of the SATS as described in paragraph 214m of this handbook. For more information on the SATS, refer to TI 6480.1 volume 7.
- (10) Verify proper configuration of the CDPs as described in paragraph 214n of this handbook. For more information on the CDPs, refer to TI 6480.1 volume 5.
- (11) Verify proper operation and configuration of the Control and Interrogation Power Systems as described in paragraph 214o of this handbook. For more information on the Control and Interrogation Power Systems refer to TI 6480.1 volume 2.

505. 8 Hour Performance Checks for DRPDS While Operating on Commercial Power.

a. Object. These procedures establish guidelines for performance checks for the operation of the Power Monitoring and Control System (PCMS), Switchgear (SWGR) 1 & 2, Paralleling Switchgear (PSG), Engine Generators (EGs), Engine Generator (EG) Auxiliary Equipment, Switchboard (SWBD) 1 & 2, Motor Control Center (MCC), UPS Switchgear (SWGR), the Uninterruptible Power Systems

(UPSs), the UPS Output Switchboards (SWBDs), Critical Buses, Power Distribution Units (PDUs), Static Automatic Transfer Switches (SATS), Critical Distribution Panels (CDPs), and the AC/DC Control and Interrogation Power Systems of the DRPDS system while operating on commercial power.

b. Discussion. Prior to conducting any preventive maintenance, ensure that risk assessment and mitigation has been conducted in accordance with paragraph 104 of this handbook, additionally, all work that could impact air traffic should be coordinated with air traffic control (ATC). During operation of the DRPDS system on commercial power, it is critical to perform 8 hour performance checks on the PMCS, SWGR 1, SWGR 2, PSG, EG and EG auxiliary equipment, SWBD 1, SWBD 2, the MCCs, the UPS SWGR, the UPSs, the UPS Output SWBDs, the Critical Buses, the PDUs, the SATS, the CDPs and the AC/DC Control and Interrogation Power Systems in order to ensure proper operation and configuration of the DRPDS system while operating on stand by power.

c. Conditions. DRPDS system operating on commercial power in accordance with paragraph 208 of this handbook.

d. Detailed Procedures.

(1) Verify proper operation and configuration of the PMCS as described in paragraph 208a of this handbook. For more information on the PMCS, refer to TI 6480.1 volume 9.

(2) Verify proper operation and configuration of SWGR 1 and SWGR 2 as described in paragraph 208b of this handbook. For more information on SWGR 1 and SWGR 2, refer to TI 6480.1 volume 2.

(3) Verify proper operation and configuration of the PSG as described in paragraph 208c of this handbook. For more information on the PSG, refer to TI 6480.1 volume 4.

(4) Verify proper operation and configuration of the EGs as described in paragraph 208d of this handbook. For more information on the EGs, refer to TI 6480.1 volume 3.

(5) Verify proper operation and configuration of the EG auxiliary equipment as described in paragraph 208e of this handbook. For more information on the EG auxiliary equipment, refer to TI 6480.1 volume 3.

(6) Verify proper operation and configuration of SWBD 1 and SWBD 2 as described in paragraph 208f of this handbook. For more information on SWBD 1 and SWBD 2, refer to TI 6480.1 volume 2.

(7) Verify proper operation and configuration of the MCCs as described in paragraph 208g of this handbook. For more information on the MCCs, refer to TI 6480.1 volume 5.

(8) Verify proper operation and configuration of the UPS SWGR as described in paragraph 208h

of this handbook. For more information on the UPS SWGR, refer to TI 6480.1 volume 2.

(9) Verify proper operation and configuration of the UPSs as described in paragraph 208i of this handbook. For more information on the UPSs, refer to TI 6480.1 volume 6.

(10) Verify proper operation and configuration of the UPS Output Switchboards as described in paragraph 208j of this handbook. For more information on the UPS Output Switchboards, refer to TI 6480.1 volume 5.

(11) Verify proper configuration of the Critical Buses as described in paragraph 208k of this handbook. For more information on the critical buses, refer to TI 6480.1 volume 8.

(12) Verify proper configuration of the PDUs as described in paragraph 208l of this handbook. For more information on the PDUs, refer to TI 6480.1 volume 7.

(13) Verify proper operation and configuration of the SATS as described in paragraph 208m of this handbook. For more information on the SATS, refer to TI 6480.1 volume 7.

(14) Verify proper configuration of the CDPs as described in paragraph 208n of this handbook. For more information on the CDPs, refer to TI 6480.1 volume 5.

(15) Verify proper operation and configuration of the Control and Interrogation Power Systems as described in paragraph 208o and 208p of this handbook. For more information on the Control and Interrogation Power Systems refer to TI 6480.1 volume 2.

506. Daily Fuel Filtration.

a. Object. This procedure establishes the fuel filtration schedule used by the PMCS to exercise the fuel system on a daily basis.

b. Discussion. Prior to conducting any preventive maintenance, ensure that risk assessment and mitigation has been conducted in accordance with paragraph 104 of this handbook, additionally, all work that could impact air traffic should be coordinated with air traffic control (ATC). In accordance with paragraph 302a(4)(a)8 of this handbook, each main fuel tank must undergo two volume changes per week. In order to accomplish the prescribed volume changes, the fuel filtration system is operated 5 hours each day, alternating between the two main fuel tanks (e.g., main tank 1 is filtered for 5 hours Monday and main tank 2 is filtered for 5 hours Tuesday.) This procedure utilizes PMCS operator workstation (OWS) graphical user interface (GUI) controls. The PMCS must be operational with Monitor Pro (MPRO) GUI software running to perform this procedure. Reference TI 6480.1, volume 9 for directions on operating the PMCS OWS GUI controls.

c. Conditions. DRPDS system operating on commercial power in accordance with paragraph 208 of this handbook.

d. Procedure.

- (1) At the PMCS OWS select the GRAPHICS INDEX screen.
- (2) At the GRAPHICS INDEX screen, select the GENERATORS screen (second column on the left near the bottom.)
- (3) Select the FILTRATION SCHEDULER from the top row of the GENERATORS screen.
- (4) Select Monday, Wednesday, and Friday for MAINTANK 1 FILTER.
- (5) Set MAINTANK 1 START TIME for 12:00.
- (6) Set MAINTANK 1 FILTRATION DURATION for 5 hours and 0 minutes.
- (7) Select Tuesday, Thursday, and Saturday for MAINTANK 2 FILTER.
- (8) Set MAINTANK 2 START TIME for 12:00.
- (9) Set MAINTANK 2 FILTRATION DURATION for 5 hours and 0 minutes.
- (10) Press ACCEPT (bottom of the screen).

507. Commercial Power Transformer Preventive Maintenance.

a. Object. The procedure below provides a list of metrics that shall be recorded on a monthly basis.

b. Discussion. Prior to conducting any preventive maintenance, ensure that risk assessment and mitigation has been conducted in accordance with paragraph 104 of this handbook, additionally, all work that could impact air traffic should be coordinated with air traffic control (ATC). Preventive maintenance to commercial transformers is conducted by the local utility at the local utility's discretion. However, as a part of the monthly maintenance routine, the transformers oil temperature, oil level, and tank pressure should be taken. Detailed procedures have not been developed as the commercial power transformer provided by the local utility company may vary between sites. For additional information on how to take the readings described in paragraph 507c, consult the local utility company or call the Power Services Office in Oklahoma City, OK at 1-800-475-2667.

c. Procedure.

- (1) Read and record maximum transformer oil temperature and reset indicator.
- (2) Read and record transformer oil level.
- (3) Read and record tank pressure.

508. UPS Monthly Performance Checks.

a. Object. The batteries used for stand by power in an uninterruptible power system must be checked for signs of degradation on a regular basis in order to insure their availability when needed.

b. Discussion. Prior to conducting any preventive maintenance, ensure that risk assessment and mitigation has been conducted in accordance with paragraph 104 of this handbook, additionally, all work that could impact air traffic should be coordinated with air traffic control (ATC). Batteries used for stand by power in an uninterruptible power system must have a visual inspection for signs of physical breakdown and damage. The battery cell voltages must also be taken in to establish a health index for the batteries. A healthy battery is defined as a battery conforming to the tolerances prescribed in paragraph 303f of this handbook.

c. Conditions. DRPDS system operating on commercial power in accordance with paragraph 208 of this handbook.

d. Procedure.

(1) Perform a general inspection of the physical condition of the batteries as described in TI 6480.1, part 3, book 1, tab 9, page 6 (Quarterly Maintenance steps 1-8).

(2) Perform battery cell voltage checks by measuring across the positive and negative terminal of each battery in the string individually using an Alber Cellcorder. For instruction on the set up and use of the Alber Cellcorder, refer to TI 6480.1, volume 8, part 1, book 3, tab 3, section 3. Retain the test data for trending purposes.

509. Engine Generator Monthly Performance Checks.

a. Object. Each EG used for stand by power at a DRPDS supported facility should be started and exercised on the interval described in paragraph 302a in order to verify proper operation and to prevent wet stacking from occurring.

b. Discussion. Prior to conducting any preventive maintenance, ensure that risk assessment and mitigation has been conducted in accordance with paragraph 104 of this handbook, additionally, all work that could impact air traffic should be coordinated with air traffic control (ATC). Each EG at a facility utilizing a DRPDS power system should be started and exercised. The load applied to the EG should be at least 60% of the load rating on the nameplate of the EG. Operating the EG at a minimum of 60% load until the coolant temperature has stabilized in it's normal operating range will evaporate any moisture that may have condensed in the crankcase and prevent wet-stacking.

c. Conditions. DRPDS system operating on commercial power in accordance with paragraph 208 of this handbook.

d. Procedure. Exercise each EG from corresponding Individual EG Control Panel. (Ensure the applied load is 60% of rated load or higher until the coolant temperature is stable in its normal operating temperature range.) For additional information, reference TI 6480.1, volume 3.

510. Transient Voltage Surge Suppressor (TVSS) Monthly Performance Checks.

a. Object. Transient voltage surge suppressors are utilized to prevent high voltage transients from reaching and negatively affecting the critical loads down stream of the TVSS.

b. Discussion. Prior to conducting any preventive maintenance, ensure that risk assessment and mitigation has been conducted in accordance with paragraph 104 of this handbook, additionally, all work that could impact air traffic should be coordinated with air traffic control (ATC). There is not a lot of preventive maintenance required to maintain a TVSS module. Most TVSS modules will be equipped with some form of indicator light or lights for each phase in a 3 phase power system. Some TVSS modules may be equipped with a built in test function that will require the user to depress the test button to test the TVSS module.

c. Conditions. DRPDS system operating on commercial power in accordance with paragraph 208.

d. Procedure. If the TVSS used at a DRPDS facility has a test feature, initiate that test feature by depressing the test button on the TVSS module. If the TVSS used at a DRPDS facility does not have a test feature built into the TVSS, verify proper TVSS operation by verifying the status of the indicator lights on the TVSS module. This process should be repeated for each TVSS in the DRPDS power system. For information about specific TVSS modules refer to TI 6480.1 volume 2, part 1, book 1, tabs 24 and 25 and volume 8, part 1, book 2, tabs 1-5.

511. Monthly Transfer Switch Operation for Control and Interrogation Power Systems.

a. Object. The transfer switches used in the ac and dc power systems used for control and interrogation in DRPDS system need to be exercised on a monthly basis.

b. Discussion. Prior to conducting any preventive maintenance, ensure that risk assessment and mitigation has been conducted in accordance with paragraph 104 of this handbook, additionally, all work that could impact air traffic should be coordinated with air traffic control (ATC). The ASCO 940, 962, and 7000 model transfer switches are equipped with control switches to command the transfer switch to transfer from Normal to Emergency and from Emergency to Normal. The transfer switches should be exercised by transferring sources via the control switch on a monthly basis in order to verify proper operation.

c. Conditions. DRPDS system operating on commercial power in accordance with paragraph 208 of this handbook.

d. Procedure. The ASCO 940, 962, and 7000 series transfer switches are slightly different therefore the procedure for transferring these switches will vary accordingly. The procedures for electrically transferring the ASCO transfer switches can be found at the found at the following locations:

ASCO 940 - TI 6480.1, volume 8, part 1, book 1, tab 6, section 3-1.

ASCO 962 - TI 6480.1, volume 8, part 1, book 1, tab 7, section 3-3.

ASCO 7000 - TI 6480.1, volume 8, part 1, book 1, tab 10, Section 1-5.

512. PMCS Quarterly Performance Checks.

a. Object. The Power Monitoring and Control System (PMCS) operates as a monitoring and supervisory control System. Quarterly performance checks will verify that the PMCS is operating properly.

b. Discussion. Prior to conducting any preventive maintenance, ensure that risk assessment and mitigation has been conducted in accordance with paragraph 104 of this handbook, additionally, all work that could impact air traffic should be coordinated with air traffic control (ATC). Quarterly performance checks are necessary to ensure that the PMCS will react appropriately to a loss of utility power.

c. Conditions. DRPDS system operating on commercial power in accordance with paragraph 208 of this handbook.

d. Procedure.

(1) Using the PMCS Operator Work Station (OWS), transfer the DRPDS loads between SWGR 1 and SWGR 2. After successful completion of the transfers, return the system to the normal state.

(2) Verify that the DRPDS power system is operating in accordance with paragraph 208 while on utility power. Simulate a utility power outage at SWGR 1 or SWGR 2. Both SWGR 1 and SWGR 2 incorporate a fused disconnect containing the F3 utility sensing fuses. To simulate a utility power outage, open the fused disconnect containing the F3 utility sensing fuses located in circuit 271, 273, and 275 for either SWGR 1 or SWGR 2. If the utility power outage is simulated at SWGR 1, verify that the DRPDS power system automatically transitions to the configuration described in paragraph 209. If the utility power outage is simulated at SWGR 2, verify that the DRPDS power system transitions to the configuration described in paragraph 211 of this handbook.

(3) After verifying that the DRPDS power system reconfigured correctly in response to the utility outage, restore utility power to the SWGR from which it was removed by closing the fused disconnect that was opened in paragraph 512(d)(2) of this order. When utility power is restored at SWGR 1, verify that the DRPDS power system transitions to the configuration described in paragraph 210 of this handbook. When utility power is restored at SWGR, verify that the DRPDS power system transitions to the configuration described in paragraph 212 of this handbook. For more information about the PMCS system, please refer to TI 6480.1, volume 9.

Note: The utility power outage simulation should be rotated between SWGR 1 and SWGR 2 quarterly.

513. DC System Quarterly Performance Checks.

a. Object. The 125V dc Control Power System incorporates the use of ALCAD batteries. The procedure below describes the quarterly maintenance that is to be done to the battery string.

b. Discussion. Prior to conducting any preventive maintenance, ensure that risk assessment and mitigation has been conducted in accordance with paragraph 104, additionally, all work that could impact air traffic should be coordinated with air traffic control (ATC). The plates and electrolyte within a battery will deteriorate over time, by measuring and recording the individual battery voltages and noting a drastic change in voltage level, the health of a battery can be determined.

c. Conditions. DRPDS system operating on commercial power in accordance with paragraph 208 of this handbook.

d. Procedure. Using an Alber Cellcorder, or similar device, measure the individual battery voltage of each battery in each string by measuring across the positive and negative terminals. For instruction on the use of the Alber cellcorder, please refer to TI 6480.1, volume 8, part 1, book 3, tab 3.

514. Semiannual Utility Outage Test.

a. Object. The purpose of this test is to verify proper operation of the DRPDS power system in the event of utility outage.

b. Discussion. Prior to conducting any preventive maintenance, ensure that risk assessment and mitigation has been conducted in accordance with paragraph 104 of this handbook, additionally, all work that could impact air traffic should be coordinated with air traffic control (ATC). The PMCS is responsible for all automated breaker operation. By simulating a utility power failure, proper control of the DRPDS power system by the PMCS can be verified.

c. Conditions. Verify that the DRPDS power system is operating in accordance with paragraph 208, of this handbook, while on utility power.

d. Procedure.

(1) Simulate a utility power outage at SWGR 1 and SWGR 2 simultaneously. Both SWGR 1 and SWGR 2 incorporate a fused disconnect containing the F3 utility sensing fuses. To simulate a utility power outage, open the fused disconnect containing the F3 utility sensing fuses located in circuit 271, 273, and 275 for both SWGR 1 and SWGR 2. Verify proper transfer to stand by power in accordance with paragraph 213, then verify proper operation on stand by power in accordance with paragraph 214 of this handbook.

(2) Record the EG number and the elapsed time from the beginning of the simulation to the time that it takes for the first and second generator breakers to close on the PSG.

(3) Record elapsed time for the last generator breaker to close onto the PSG.

(4) Record elapsed time starting from the first generator breaker closing to when breakers 1M2 and 2M2 close.

(5) Record elapsed time starting from when the first generator breaker closes to when feeder breakers close on the UPS SWGR, SWBD 1 and SWBD 2.

(6) Record elapsed time starting from when C1A and C1B close to when each UPM rectifier turns on.

(7) Record elapsed time starting from last EG breaker closing until first EG shuts down under PMCS engine management.

(8) Record UPS battery cell number and voltage for any cell that drops below the DC Tracker low cell shutdown alarm.

(9) Record number of engines running with breakers closed after all loads have transferred and at 30-minute intervals during test.

Note: Record items 514(d)(9) through 514(d)(24) for each engine at 30-minute intervals and run engines with engine management for a minimum of 2 hours.

- (10) Record any PSG alarms.
- (11) Record output kVARs for each engine.
- (12) Record output kilowatts for each engine.
- (13) Record output frequency for each engine.
- (14) Record output voltage for each engine.
- (15) Record coolant temperature for each engine.
- (16) Record fuel oil inlet header pressure for each engine.
- (17) Record lube oil pressure for each engine.
- (18) Record lube oil temperature for each engine.
- (19) Record inlet air manifold pressure for each engine.

(20) Check exhaust fans in operation if room temperature exceeds thermostat setting, nominally 80 to 90 °F or above (for information only).

(21) Check fuel level in day tanks.

(22) Check radiator fans.

(23) Check day tank fuel pump.

(24) Check turbocharger for each engine.

(25) After 2 hours of EG operation, restore utility power to both SWGR 1 and SWGR 2 by closing the fused disconnect that was opened in paragraph 514(d)(1). When utility power is restored, verify that the DRPDS power system transfers back to utility power as described in paragraph 215 of this handbook. After the DRPDS power system transfers to utility power, verify that the DRPDS power system is configured as described in paragraph 208 of this handbook. For more information about the PMCS system, please refer to TI 6480.1, volume 9.

515. Engine Generator 2 Hour Run and Step Load Test.

a. Object. The purpose of the EG 2 hour run and step load performance check is to verify that the EG will operate within specification.

b. Discussion. Prior to conducting any preventive maintenance, ensure that risk assessment and mitigation has been conducted in accordance with paragraph 104 of this order, additionally, all work that could impact air traffic should be coordinated with air traffic control (ATC).

c. Conditions. DRPDS system operating on commercial power in accordance with paragraph 208. The EG to be tested should be configured to load bank.

d. Procedure.

(1) Connect and configure test equipment to the output of the EG to capture and record frequency change, voltage change and transient response time.

(2) Configure the EG that is to be tested to load bank and initiate EG run.

(3) After the EG starts, apply full rated load to the EG and record the parameters listed in paragraph 409a(2) at 30 minute intervals.

(4) After the 2 hour run, remove load from the EG. Apply a single load step that is approximately 80% of the EG's FAA rated load specification. After the EG has assumed the load, remove the 80% load step from the EG. Record EG frequency change and transient response time and EG voltage change and transient response time.

(5) Review the data captured by the test equipment. Record EG frequency change and transient response time and EG voltage change and transient response time. Look for voltage and frequency

changes that may have occurred as a result of the load steps. Also, look at the transient response time for both voltage and frequency to verify that the times adhere to FAA standards.

516. EG High Temperature Warning and Shutdown Test.

a. Object. The purpose of the EG high temperature warning and shutdown test is to verify that the EG responds properly to a high temperature condition.

b. Discussion. Prior to conducting any preventive maintenance, ensure that risk assessment and mitigation has been conducted in accordance with paragraph 104 of this handbook, additionally, all work that could impact air traffic should be coordinated with air traffic control (ATC). The test procedure below will verify that the EG will annunciate the Pre-High Coolant Temperature alarm and the High Coolant Temperature shutdown when activated.

c. Conditions. DRPDS system operating on commercial power in accordance with paragraph 208 of this handbook. Isolate the EG to be tested from the DRPDS system by opening the EG output breaker for the EG to be tested at the PSG.

d. Procedure.

(1) Initiate the EG run.

(2) To activate the High Temperature Warning for the EG, connect a jumper wire from the pre-high engine temperature switch (wire #40A) to ground on the engine. The local display should read-HIGH COOLANT TEMPERATURE WARNING. The engine should continue to run.

(3) Remove the Jumper.

(4) To activate the High Temperature Shutdown for the EG, connect a jumper wire from the high engine temperature switch terminal (wire #34) to ground on the engine. The engine should stop after 5 seconds and the local display should read - HIGH COOLANT TEMPERATURE.

(5) Remove the Jumper, after the cool down period for the EG, shut it down and close its output breaker to the EG to the DRPDS power system.

Note: There is a 30-second signal inhibit on initial starting of the engine.

517. EG Low Oil Pressure Warning and Shutdown Test.

a. Object. The purpose of the EG low oil pressure warning and shutdown test is to verify that the EG responds properly to a low oil pressure condition.

b. Discussion. Prior to conducting any preventive maintenance, ensure that risk assessment and mitigation has been conducted in accordance with paragraph 104 of this handbook, additionally, all work that could impact air traffic should be coordinated with air traffic control (ATC). The test

procedure below will verify that the EG will annunciate the Pre-Low Oil Pressure Warning and the Low Oil Pressure shutdown when activated.

c. Conditions. DRPDS system operating on commercial power in accordance with paragraph 208 of this handbook. Isolate the EG to be tested from the DRPDS system by opening the EG output breaker for the EG to be tested at the PSG.

d. Procedure.

(1) Initiate the EG run.

(2) To activate the Low Oil Pressure Shutdown for the EG, connect a jumper wire from the pre-low oil pressure switch terminal (wire #41A) to the ground on the engine. The local display should read –LOW OIL PRESSURE WARNING. The engine should continue to run.

(3) Remove the Jumper.

(4) To activate the Low Oil Pressure Shutdown for the EG, connect a jumper wire from the low oil pressure switch terminal (wire #13) to ground on the engine. The engine should stop after 5 seconds and the local display should read- LOW OIL PRESSURE.

(5) Remove the Jumper, after the cool down period for the EG, shut it down and close its output breaker to return the EG to the DRPDS power system.

Note: There is a 30-second signal inhibit on initial starting of the engine.

518. EG Low Fuel Level Warning Test.

a. Object. The purpose of the EG Low FUEL Level Warning test is to verify that the EG responds properly to a low fuel level condition in the day tank.

b. Discussion. Prior to conducting any preventive maintenance, ensure that risk assessment and mitigation has been conducted in accordance with paragraph 104 of this handbook, additionally, all work that could impact air traffic should be coordinated with air traffic control (ATC). The test procedure below will verify that the EG will annunciate the Low Fuel Level Warning when activated. Day tanks may vary by site, subsequently, the procedure below is generic and documentation referring to specific day tanks can be found in TI 6480.1.

c. Conditions. DRPDS system operating on commercial power in accordance with paragraph 208 of this handbook.

d. Procedure.

(1) Connect a jumper wire across the LOW FUEL alarm contacts in the supply day tank. The local display should read LOW FUEL.

- (2) Remove the Jumper.

519. EG Over-Crank Test.

a. Object. The purpose of the EG Over-crank test is to verify that the EG responds properly to an over-crank condition.

b. Discussion. Prior to conducting any preventive maintenance, ensure that risk assessment and mitigation has been conducted in accordance with paragraph 104 of this handbook, additionally, all work that could impact air traffic should be coordinated with air traffic control (ATC). The test procedure below will verify that the EG will annunciate the over-crank alarm when activated.

c. Conditions. DRPDS system operating on commercial power in accordance with paragraph 208 of this handbook. Isolate the EG to be tested from the DRPDS system by opening the EG output breaker for the EG to be tested at the PSG.

d. Procedure.

Caution: Do not disable the starter to perform this check. The DEC-340 will detect a Locked Rotor condition.

- (1) Place the DEC-340 controller master switch in the OFF position.
- (2) Locate the governor actuator.
- (3) Remove one of the leads to the actuator to prevent the engine from starting.
- (4) Select Menu 4 on the controller.
- (5) Scroll down and locate "TIME DELAY CRANK ON" Record: _____

Note: This is the amount of time the engine will crank during the cycle.

- (6) Locate "TIME DELAY CRANK PAUSE" Record: _____

Note: This is the amount of time the engine will be off during the cycle.

- (7) Locate "OVERCRANK SHUTDOWN CYCLES" Record: _____

Note: This is the number of times the engine will attempt to crank before the controller will issue an OVERCRANK shutdown.

- (8) Place the controller master switch in the RUN position. This will engage the starter motor.

(9) Start timing the start cycle. The engine should crank for the time noted in step 520d(5), then pause for the time noted in step 520d(6). It should repeat this cycle by the number indicated in step 520d(7).

(10) Observe the DEC-340 when the engine shuts down. The display should read OVERCRANK and the SHUTDOWN lamp is illuminated.

520. EG Low Coolant Level Shutdown Test.

a. Object. The purpose of the EG Low Coolant Level Warning and Shutdown test is to verify that the EG responds properly to a low coolant level condition.

b. Discussion. Prior to conducting any preventive maintenance, ensure that risk assessment and mitigation has been conducted in accordance with paragraph 104 of this handbook, additionally, all work that could impact air traffic should be coordinated with air traffic control (ATC). The test procedure below will verify that the EG will perform the Low Coolant Level shutdown when activated.

c. Conditions. DRPDS system operating on commercial power in accordance with paragraph 208 of this handbook. Isolate the EG to be tested from the DRPDS system by opening the EG output breaker for the EG to be tested at the PSG.

d. Procedure.

(1) Initiate the EG run.

(2) To activate the Low Coolant Level shutdown for the EG, connect a jumper wire from the low coolant level switch terminal (wire 31A) to a ground on the radiator support. The engine should stop after approximately 5 seconds and the local display should read- LOW COOLANT LEVEL.

(3) Remove the Jumper.

(4) After the cool down period for the EG, shut it down and close EG output breaker to return the EG to service in the DRPDS power system.

Note: There is a 30-second signal inhibit on initial starting of the engine.

521. EG Not-in-Auto Lamp Test.

a. Object. The purpose of the EG Not-In-Auto lamp test is to verify that the Not-In-Auto lamp illuminates properly.

b. Discussion. Prior to conducting any preventive maintenance, ensure that risk assessment and mitigation has been conducted in accordance with paragraph 104 of this handbook, additionally, all work that could impact air traffic should be coordinated with air traffic control (ATC). The test

procedure below will verify that the Not-In-Auto Lamp will illuminate when activated.

c. Conditions. DRPDS system operating on commercial power in accordance with paragraph 208 of this handbook.

d. Procedure. Verify that the Not-In-Auto lamp illuminates and the audible alarm sounds whenever the master switch is in the OFF/RESET or RUN positions.

522. EG Emergency Stop Test.

a. Object. The purpose of the EG emergency stop test is to verify that the EG responds correctly to the emergency stop command.

b. Discussion. Prior to conducting any preventive maintenance, ensure that risk assessment and mitigation has been conducted in accordance with paragraph 104 of this handbook, additionally, all work that could impact air traffic should be coordinated with air traffic control (ATC). The test procedure below will verify that the EG will shut down when the emergency stop button is activated.

c. Conditions. DRPDS system operating on commercial power in accordance with paragraph 208 of this handbook. Isolate the EG to be tested from the DRPDS system by opening the EG output breaker for the EG to be tested at the PSG.

d. Procedure.

- (1) Start the engine by placing the DEC-340 controller master switch in the RUN position.
- (2) Once the engine stabilizes, push the Emergency Stop switch on the controller.
- (3) The engine should immediately shut down.
- (4) Verify the DEC-340 display reads EMERGENCY STOP and the SHUTDOWN lamp is illuminated.
- (5) Reset the controller by placing the master switch to off and manually pulling out the Emergency Stop switch (some may require a 1/4 turn while pulling out).
- (6) Close EG output breaker to return the EG to service in the DRPDS power system.

523. EG Over-Voltage Shutdown Test.

a. Object. The purpose of the EG over-voltage test is to verify that the EG responds correctly to an over-voltage condition.

b. Discussion. Prior to conducting any preventive maintenance, ensure that risk assessment and mitigation has been conducted in accordance with paragraph 104 of this handbook, additionally, all

work that could impact air traffic should be coordinated with air traffic control (ATC). The test procedure below will verify that the EG will shut down when an over-voltage condition occurs.

c. Conditions. DRPDS system operating on commercial power in accordance with paragraph 208 of this handbook. Isolate the EG to be tested from the DRPDS system by opening the EG output breaker for the EG to be tested at the PSG.

d. Procedure.

(1) Connect a calibrated VOM to the output of the generator. Ensure the meter is set to V ac.

(2) Select Menu 6 on the DEC-340 Controller.

(3) Scroll down and locate the "OVERVOLTAGE" set point.

Record: _____% _____ V ac.

(4) Select Menu 4 on the controller.

(5) Scroll down and locate the "OVERVOLTAGE TIME DELAY" set point.

Record: _____seconds

(6) Place the controller master switch in the RUN position.

(7) Utilizing the VOM, record the generator out put voltage.

Original Voltage set point: _____ V ac.

(8) Locate the DVR2000 voltage regulator.

(9) Ensure the DVR2000 is in the fine voltage adjustment mode(see TI 6480.1 volume 3, part 1, book 1, tab 3).

Note: In the fine voltage adjustment mode, one press of the UP button equals a .5 volt increase of the generator output

(10) While monitoring the VOM, slowly increase the generator output voltage to the level recorded in step 524d(3) by pressing the UP button on the DVR2000.

(11) After the time delay recorded in step 524d(5) expires, the engine should shut down.

(12) Verify the DEC-340 display reads OVERVOLTAGE and the SHUTDOWN lamp is illuminated.

(13) Reset the DEC-340 and ensure all alarms are clear.

(14) Restart the engine and monitor the VOM. The voltage should return to the original set point (step 524d(7)). If not, quickly decrease the voltage using the DVR2000 to the original set point to prevent a repeat shutdown on over-voltage.

(15) Close EG output breaker to return the EG to service in the DRPDS power system.

524. EG Under-Voltage Shutdown Test.

a. Object. The purpose of the EG under-voltage test is to verify that the EG responds correctly to an under-voltage condition.

b. Discussion. Prior to conducting any preventive maintenance, ensure that risk assessment and mitigation has been conducted in accordance with paragraph 104 of this handbook, additionally, all work that could impact air traffic should be coordinated with air traffic control (ATC). The test procedure below will verify that the EG will shut down when an under-voltage condition occurs.

c. Conditions. DRPDS system operating on commercial power in accordance with paragraph 208 of this handbook. Isolate the EG to be tested from the DRPDS system by opening the EG output breaker for the EG to be tested at the PSG.

d. Procedure.

(1) Connect a calibrated VOM to the output of the generator. Ensure the meter is set to V ac.

(2) Select Menu 6 on the DEC-340 Controller.

(3) Scroll down and locate the “UNDERVOLTAGE” set point.

Record: _____% _____ V ac.

(4) Select Menu 4 on the controller.

(5) Scroll down and locate the “UNDERVOLTAGE TIME DELAY” set point.

Record: _____seconds

(6) Place the controller master switch in the RUN position.

(7) Utilizing the VOM, record the generator output voltage.

Original Voltage set point: _____ V ac.

(8) Locate the DVR2000 voltage regulator.

(9) Ensure the DVR2000 is in the coarse voltage adjustment mode (see TI 6480.1 volume 3, part 1, book 1, tab 3).

Note: In the coarse voltage adjustment mode, one press of the DOWN button equals a 6 volt decrease of the generator Output.

(10) While monitoring the VOM, slowly decrease the generator output voltage to roughly 5 volts above the level recorded in step 525d(3) by pressing the DOWN button on the DVR2000.

(11) Place the DVR2000 into the fine adjust mode (see TI 6480.1 volume 3, part 1, book 1, tab 3).

Note: In the fine voltage adjustment mode, one press of the DOWN button equals a .5 decrease of the generator output

(12) Continue to monitor the VOM, and slowly press the DOWN button until the generator output voltage is equal to the level recorded in step 525d(3).

(13) After the time delay recorded in step 525d(5) expires, the engine should shut down.

(14) Verify the DEC-340 display reads UNDERVOLTAGE and the SHUTDOWN lamp is illuminated.

(15) Reset the DEC-340 and ensure all alarms are clear.

(16) Restart the engine and monitor the VOM. The voltage should return to the level obtained in step 525d(9) (roughly 5 v the under-voltage level).

(17) Place the DVR2000 in the course voltage adjustment mode and slowly increase the generator output voltage to roughly 5 volts below the original value (step 525d(7)).

(18) Place the DVR2000 in the fine adjustment mode and slowly increase the generator output to the original set point (step 525d(7)).

(19) Press the SELECT button on the DVR2000 or let the engine continue to run for over one minute to store this set point into the DVR2000's memory (see TI 6480.1 volume 3, part 1, book 1, tab 3).

(20) After the cool down period for the EG, shut it down and close EG output breaker to return the EG to service in the DRPDS power system.

525. EG Under-Frequency Shutdown Test.

a. Object. The purpose of the EG under-frequency shutdown test is to verify that the EG responds correctly to an under-frequency condition.

b. Discussion. Prior to conducting any preventive maintenance, ensure that risk assessment and mitigation has been conducted in accordance with paragraph 104 of this handbook, additionally, all work that could impact air traffic should be coordinated with air traffic control (ATC). The test procedure below will verify that the EG will shut down when an under-frequency condition occurs.

c. Conditions. DRPDS system operating on commercial power in accordance with paragraph 208 of this handbook. Isolate the EG to be tested from the DRPDS system by opening the EG output breaker for the EG to be tested at the PSG.

d. Procedure.

(1) Connect a calibrated VOM to the output of the generator. Ensure the meter is set to read frequency.

(2) Select Menu 6 on the DEC-340 Controller.

(3) Scroll down and locate the "UNDERFREQUENCY" set point.

Record: _____% _____HZ.

(4) Place the controller master switch in the RUN position.

(5) On the governor controller locate the speed potentiometer.

(6) While monitoring the VOM, slowly adjust the potentiometer to decrease the speed of the engine until the under-frequency set point (step 3) is reached.

(7) After approximately 10 seconds the engine should shutdown.

(8) Verify the DEC-340 display reads UNDERFREQUENCY and the SHUTDOWN lamp is illuminated.

Note: Before attempting to restart the engine, rotate the speed adjustment potentiometer back 1/8 of a turn to prevent the engine from a repeat shutdown.

(9) Reset the DEC-340 controller and restart the engine.

(10) While monitoring the VOM, slowly adjust the speed potentiometer until the frequency is set to the original set point (60HZ).

(11) After the cool down period for the EG, shut it down and close EG output breaker to return the EG to service in the DRPDS power system.

526. EG Over-Frequency Shutdown Test.

a. Object. The purpose of the EG over-frequency shutdown test is to verify that the EG responds

correctly to an over-frequency condition.

b. Discussion. Prior to conducting any preventive maintenance, ensure that risk assessment and mitigation has been conducted in accordance with paragraph 104 of this handbook, additionally, all work that could impact air traffic should be coordinated with air traffic control (ATC). The test procedure below will verify that the EG will shut down when an over-frequency condition occurs.

c. Conditions. DRPDS system operating on commercial power in accordance with paragraph 208 of this handbook. Isolate the EG to be tested from the DRPDS system by opening the EG output breaker for the EG to be tested at the PSG.

d. Procedure.

(1) Connect a calibrated VOM to the output of the generator. Ensure the meter is set to read frequency.

(2) Select Menu 6 on the DEC-340 Controller.

(3) Scroll down and locate the "OVERFREQUENCY" set point.

Record: _____% _____HZ.

(4) Place the controller master switch in the RUN position.

(5) On the governor controller locate the speed potentiometer.

(6) While monitoring the VOM, slowly adjust the potentiometer to increase the speed of the engine until the over-frequency set point (step 527d(3)) is reached.

(7) After approximately 10 seconds the engine should shutdown.

(8) Verify the DEC-340 display reads OVERFREQUENCY and the SHUTDOWN lamp is illuminated.

Note: Before attempting to restart the engine, rotate the speed adjustment potentiometer back 1/8 of a turn to prevent the engine from a repeat shutdown.

(9) Reset the DEC-340 controller and restart the engine.

(10) While monitoring the VOM, slowly adjust the speed potentiometer until the frequency is set to the original set point (60HZ).

(11) After the cool down period for the EG, shut it down and close EG output breaker to return the EG to service in the DRPDS power system.

527. EG Low Battery Voltage Test.

a. Object. The purpose of the EG low battery test is to verify that the EG responds correctly to a low battery condition.

b. Discussion. Prior to conducting any preventive maintenance, ensure that risk assessment and mitigation has been conducted in accordance with paragraph 104 of this handbook, additionally, all work that could impact air traffic should be coordinated with air traffic control (ATC). The test procedure below will verify that the EG will annunciate the low battery alarm when a low battery voltage condition occurs.

c. Conditions. DRPDS system operating on commercial power in accordance with paragraph 208 of this handbook.

d. Procedure.

(1) Enter local programming mode and access Menu 9 (calibration).

(2) Under Battery Voltage enter 22V dc.

(3) Exit from calibration and after 10 seconds the local display should read- LOW BATTERY VOLTAGE.

(4) Once verified, reenter the calibration menu and scroll down until the display reads Battery Voltage.

(5) Obtain a VOM and read the actual voltage at the batteries with the charger off. Enter this value into the DEC-340.

(6) Exit from the calibration menu and select Menu 7 (engine status). Scroll down until Battery VDC is shown. With the VOM verify the value on the controller is accurate.

(7) Return the controller to normal status by exiting the programming mode.

528. EG High Battery Voltage Test.

a. Object. The purpose of the EG high battery test is to verify that the EG responds correctly to a high battery condition.

b. Discussion. Prior to conducting any preventive maintenance, ensure that risk assessment and mitigation has been conducted in accordance with paragraph 104 of this handbook, additionally, all work that could impact air traffic should be coordinated with air traffic control (ATC). The test procedure below will verify that the EG will annunciate the high battery alarm when a high battery voltage condition occurs.

c. Conditions. DRPDS system operating on commercial power in accordance with paragraph 208 of this handbook.

d. Procedure.

(1) Enter local programming mode and access Menu 9 (calibration).

(2) Under Battery Voltage enter 36V dc.

(3) Exit from calibration and after 10 seconds the local display should read- HIGH BATTERY VOLTAGE.

(4) Once verified, reenter the calibration menu and scroll down until the display reads Battery Voltage.

(5) Obtain a VOM and read the actual voltage at the batteries with the charger off. Enter this value into the DEC-340.

(6) Exit from the calibration menu and select Menu 7 (engine status). Scroll down until Battery VDC is shown. With the VOM verify the value on the controller is accurate.

(7) Return the controller to normal status by exiting the programming mode.

529. Automatic Transfer Test (UV) For Control and Interrogation Power Systems.

a. Object. The purpose of the control and interrogation power transfer switch test is to verify proper operation of the transfer switches used in the control and interrogation power system.

b. Discussion. Prior to conducting any preventive maintenance, ensure that risk assessment and mitigation has been conducted in accordance with paragraph 104 of this handbook, additionally, all work that could impact air traffic should be coordinated with air traffic control (ATC). Proper operation of the transfer switch can be verified by simulating an under-voltage condition on the feeder to the preferred source while the transfer switch is on the preferred source.

c. Conditions. DRPDS system operating on commercial power in accordance with paragraph 208 of this handbook.

d. Procedure.

(1) Locate the two feeder breakers to the transfer switch that is to be tested.

(2) Verify that both sources are available to the transfer switch.

(3) Verify that the transfer switch is in its preferred source (normally source 1).

(4) Open the feeder breaker that is supplying the transfer switch's preferred source. This will cause the transfer switch to sense an under-voltage condition on the preferred source and force the transfer switch to transfer to its secondary source.

(5) Verify that the loads being fed from the transfer switch remain operative.

(6) Close the feeder breaker that was opened in step 529d(4) of this procedure. When the transfer switch times out, it will transfer back to its preferred source.

* **530. Verify Proper SATS Operation from the Front Display Panel.**

a. Object. Check the front control display panel for any indication of static transfer switch (STS) alarms or events.

b. Discussion. The SATS protects the critical loads from power disruptions by automatically switching from a deteriorating preferred power source to a secondary power source within four milliseconds. A status change or alarm indicated on the SATS front display screen may indicate a degradation of power occurred somewhere upstream of the SATS in the DRPDS. A status change or alarm also may indicate an internal error within the SATS unit.

c. Conditions. Unless maintenance is being performed, the SATS shall be in accordance with paragraph 208, DRPDS operation on commercial power.

d. Detailed Procedure. Each SATS should be monitored daily for the presence of alarms and conditions that differ from paragraph 208, DRPDS operation on commercial power. Check the front control panel for any status changes and verify that an alarm condition is not indicated on the display panel. Also, from the Main Menu screen, proceed to the Events Log screen. After a moment, the most recent 512 significant event messages will be displayed on the screen. Check the events screen for any status changes or alarms that have occurred since the last check. An audible alarm should also be heard if an SATS event has occurred. If a status change or alarm has occurred, the cause of the event needs to be determined. Additional troubleshooting or corrective action may be required. See the L3 static switch Technical Manual For Static Transfer Switch 150-600Amps for additional information regarding alarms, control logic fault functions, and data logger events messages.

531. Annual SATS Inspections.

WARNING: Use local lockout/tagout procedures when energizing, startup, or release of energy can occur. This is necessary to make sure that other personnel cannot start the power source during maintenance. Shock hazards can kill. Such procedures are a requirement from the latest version of Order 3900.19, FAA Occupational Safety and Health.

a. Object. Annual inspections for the static automatic transfer switch (SATS) should be performed to prevent any potential developing problems within the SATS unit before they affect National Airspace System (NAS) critical loads.

b. Discussion. Prior to conducting any periodic maintenance, perform risk assessment and

*

* mitigation. Prior to beginning any periodic maintenance procedure, read the procedure in its entirety in order to fully understand the task and the implications of performing said task.

c. Conditions. Annual performance checks and maintenance requires isolating the SATS from critical loads. Isolate the SATS in accordance with the following steps:

(1) Set or verify the DRPDS configuration in accordance with chapter 4 paragraph 403b of this handbook.

(2) Prior to unloading the SATS, verify both SATS in the effected Critical Group are switched to the same source. For example, if unloading SATS1A, perform a manual transfer to Source 2 to match the configuration of SATS1B. This will eliminate the paralleling of UPS2 and UPS3 during the close transition unloading process performed by the PMCS.

(3) Place the affected Critical Group into the Maintenance Mode via the Operator Workstation (OWS). From the Maintenance options, select the appropriate DE-EN SATSX-X.

(4) Verify the effected CDP performed a close transition cross tie operation.

(5) Verify the associated PDU output breakers are open and perform local lockout/tagout procedures.

d. Detailed Procedure. After the STS is isolated from facility loads perform the following:

(1) Infrared Scan. Open the lower panel of the SATS unit. Using an infrared camera or infrared gun, check for hot spots in the power connections. It is important to scan the power connections immediately after the SATS is isolated in order to see an accurate thermal image of the heat generated under ordinary loads. If the temperature rises above 65°C, check the power connection hardware and re-torque as required. For torque values for power connections and further information regarding the static transfer switch, refer to the L3 static switch Technical Manual For Static Transfer Switch 150-160 Amps.

(2) Visual Inspection. Verify the STS is completely de-energized and no voltages are present at SATS power connections. Pull and inspect all control fuses. Perform a thorough visual inspection of the entire unit. Check for discoloration of wire harness, cables, and components. Also, check for dust and debris accumulation within the STS and clean as necessary. If needed, check airflow and ventilation.

532. Annual SATS Performance Checks Using Powerlogic SMS-3000 Software.

a. Object. Annual inspections for the static automatic transfer switch (SATS) should be performed to verify proper operation. Annual performance checks are also needed to prevent potential developing problems within the SATS unit before they affect National Airspace System (NAS) critical loads.

b. Discussion. Prior to conducting any periodic maintenance, perform risk assessment and mitigation. Prior to beginning any periodic maintenance procedure, read the procedure in its entirety in order to fully understand the task and the implications of performing said task. Annual performance checks can be performed using one of two methods to capture the switch times of the SATS. The first method utilizes Powerlogic SMS-3000 software installed on the OWS and information received from the *

* Circuit Monitor 4000 (CM4000) installed on the SATS. The second method utilizes a Lines Disturbance Analyzer (LDA) placed on the load side of the SATS. Both methods are acceptable and the method used is solely determined by local procedures or technician preference. If the LDA is used, refer to paragraph 533.

c. Conditions. To utilize SMS-3000 software to capture the switching times of the SATS, the following verification and setup must be performed:

(1) At the Operator Workstation (OWS), verify the SMS-3000 Server is running. If not, start the SMS-3000 Server by clicking on the SMS-3000 SERVER button on the OWS Graphics Index GUI screen. Enter the site specific username and password.

Note: The default username and password is master.

(2) Verify the SMS-3000 Client is running. If not, start the SMS-3000 Client by clicking on the SMS-3000 CLIENT button on the OWS Graphics Index Screen. Enter the site specific username and password at the login prompt.

Note: The default username and password is master.

(3) Verify the SMS-3000 Client begins its startup sequence. Once the sequence is done, verify the DRPDS system is online as indicated on the lower right corner of the client window.

(4) To open the DRPDS system, click on FILE in the upper menu selections. From the File drop down menu, click on OPEN SYSTEM. From the System window click on DRPDS and then click OPEN.

(5) To verify the disturbance parameters of the CM4000 installed on the SATS, first click on SETUP in the upper menu selections. From the Setup drop down menu, click on DEVICES/ROUTING.

(6) The Setup Device/Routing window appears. From the Devices Defined list, scroll down and click on the applicable SATS CM-4000 (for example, SATS2A CM4000).

(7) On the right hand side of the Setup Devices/Routing window, click on CONFIGURE.

(8) A Setup Device – SATSXX CM-4000 window appears. Click on the ONBOARD ALARMS/EVENTS tab.

(9) In the Waveshape folder, click on WAVESHAPEVLN. Verify the following selections and setpoints:

- (a) Enable - Selected
- (b) Threshold = 5
- (c) Upper Limit = 15
- (d) Enable Setpoint Learning - NOT selected
- (e) Priority - Priority 1 (High)
- (f) Data Logs - None selected

*

- * (g) Disturbance WFC – Selected
- (h) Adaptive WFC – NOT selected

(10) If no changes were made, click CLOSE to exit. If changes were made to any of the above setpoints or selections, click on the UPDATE button to send the changes to the CM-4000. A warning will appear informing the user the CM-4000 will perform a reset during the update process – Click YES to proceed.

(11) Repeat the steps in paragraphs 532c(5) through 532c(1)0 for the CM4000 installed on each SATS scheduled to be tested.

(12) To unload the SATS being tested, set or verify the DRPDS configuration is in accordance with chapter 4, paragraph 403b of this handbook.

(13) Prior to unloading the SATS, verify both SATS in the affected Critical Group are switched to the same source. For example, if unloading SATS1A, perform a manual transfer to Source 2 to match the configuration of SATS1B. This will eliminate the paralleling of UPS2 and UPS3 during the close transition unloading process performed by the PMCS.

(14) Place the affected Critical Group into the Maintenance Mode via the Operator Workstation (OWS). From the Maintenance options, select the appropriate UNLOAD SATSX-X.

(15) Verify the affected CDP performed a close transition cross tie operation and the SATS being tested is unloaded.

d. Detailed Procedure. Perform the following procedure to verify the switching time of the SATS.

(1) Verify the Phase Status indicator is green indicating Sources 1 and 2 are in phase. If the Phase Status indicator is red, determine and correct the cause of the out-of-phase condition before proceeding.

(2) Verify the SATS being tested is operating in Static Mode on Source 1 and Auto Retransfer is disabled.

(3) At the SATS CM4000, acknowledge the Priority 1 Alarm Log by first selecting the Alarm Menu from the CM4000 Main Menu. Select Priority 1 Alarms from the Alarm Menu. View the stored alarms and then press the Menu button to exit. A prompt appears asking the user to acknowledge the alarms, press the DOWN ARROW to change the “No” to “Yes” and then press the ENTER button. Return to the Main Menu.

(4) At the SATS, perform a manual static transfer from Source 1 to Source 2. Verify the CM4000 briefly goes into alarm as indicated by the display and flashing red LED.

(5) At the OWS, retrieve the waveform capture by first clicking on DISPLAY in the upper menu selection of SMS-3000.

(6) From the display drop down menu, click on WAVEFORM PLOTS. The Select Waveform. *

- * (7) Source window appears. Expand the All Devices folder and locate the applicable SATS CM4000 and click on it, then click OK.
- (8) The Acquire Waveform window appears. Expand the Onboard folder and then expand the Disturbance Waveform folder. Locate the file with the corresponding date/time as the manual transfer performed in paragraph 532d(4). Click on it and then click OK to upload the file. If a corresponding file does not exist, verify the time and date is correctly set on the CM4000. If the time and date are correctly set, re-verify the disturbance parameters.
- (9) Once the upload is complete, a 12-Cycle Waveform appears. Click on the 3 icon on the waveform toolbar to display all three phases simultaneously. To display only the voltage waveform, double click on the Voltage label above the graph. Locate the disturbance in the waveform using the zoom function (magnifying glass icons). Once the disturbance is found, verify the switch time is within the tolerance provided in chapter 3, paragraph 308(c) of this order.
- (10) To save a copy of the waveform for future reference, click on the *E* icon on the waveform toolbar. An Export Waveform Format window appears. Select OTHER (Selected Graph) and then click OK. An Exporting Voltage window appears. Select JPG under Export. Select FILE under Export Destination and then click BROWSE. The Save As window appears. Choose the desired location (for example, My Documents) and create an applicable file name (for example, SATS1A_ManSW_S1toS2) and then click SAVE. Click EXPORT on the Exporting Voltage window to save the waveform to the desired location. Close the waveform and return to the SATS.
- (11) At the SATS, perform a manual static transfer from Source 2 to Source 1.
- (12) Repeat steps in paragraphs 532d(5) through 532d(10) to verify the switch time.
- (13) Perform a manual transfer from Source 1 static to Source 1 bypass. Verify a make before break or close transition occurred by the absence of a Waveform Capture in SMS-3000.
- (14) Perform a manual transfer from Source 1 bypass to Source 1 static. Verify a make before break or close transition occurred by the absence of a Waveform Capture in SMS-3000.
- (15) With the SATS on Source 1 static mode, open the PDU breaker which feeds Source 1 of the SATS. Verify a transfer to Source 2 static occurred and repeat steps in paragraphs 532d(5) through 532d(10) to verify the switch time.
- (16) Close the PDU output breaker to restore Source 1 to the SATS.
- (17) With the SATS on Source 2 static mode, perform a manual transfer from Source 2 static to Source 2 bypass. Verify a make before break or close transition occurred by the absence of a Waveform Capture in SMS-3000.
- (18) Perform a manual transfer from Source 2 bypass to Source 2 static. Verify a make before break or close transition occurred by the absence of a Waveform Capture in SMS-3000.
- (19) With the SATS on Source 2 static mode, open the PDU breaker which feeds Source 2 of the SATS. Verify a transfer to Source 1 static occurred and repeat steps 532d(5) through 532d(10) to verify the switch time. *

* (20) To place the SATS back into service, verify the SATS is switched to the same source as the SATS currently supporting the critical load to prevent paralleling of UPS2 and UPS3 during the PMCS reloading process.

(21) At the OWS, on the applicable Critical Group GUI screen, click RELOAD SATSXX. Verify the PMCS reloads the affected SATS and return the Critical Group control back to Auto.

(22) Reconfigure the SATS back to normal configuration (for example, SATXA to Source 1 static mode and SATSXB to Source 2 static mode.)

533. Annual SATS Performance Checks using a Line Disturbance Analyzer (LDA).

a. Object. Annual inspections for the static automatic transfer switch (SATS) should be performed to verify proper operation. Annual performance checks are also needed to catch any potential developing problems within the SATS unit before the problems can affect National Airspace System (NAS) critical loads.

b. Discussion. Prior to conducting any periodic maintenance, perform risk assessment and mitigation. Prior to beginning any periodic maintenance procedure, read the procedure in its entirety in order to fully understand the task and implications of performing said task. Annual SATS performance checks can be performed using one of two methods to capture the switch times of the SATS. The first method utilizes Powerlogic SMS-3000 software installed on the OWS and information received from the Circuit Monitor 4000 (CM4000) installed on the SATS. The second method utilizes a Lines Disturbance Analyzer (LDA) placed on the load side of the SATS. Both methods are acceptable and the method used is solely determined by local procedures or technician preference. If the SMS-3000 software is used, refer to paragraph 532.

WARNING: Use local lockout/tagout procedures when energizing, startup, or release of energy can occur. This is necessary to make sure that other personnel cannot start the power source during maintenance. Shock hazards can kill. Such procedures are a requirement from the latest version of Order 3900.19, FAA Occupational Safety and Health.

c. Conditions. To utilize an LDA (for example, Dranetz) to capture the switching times of the SATS, the following setup must be performed:

(1) If connecting the LDA on the *A* side, perform a manual static transfer of the *A* side SATS to Source 2 in the affected Critical Group. If connecting the LDA on the *B* side, perform a manual transfer of the *B* side SATS to Source 1 in the affected Critical Group.

(2) Using the Maintenance Mode, select and de-energize the desired SATS from the PMCS OWS.

(3) Connect the voltage leads of the LDA (Dranetz 4300 or equivalent) to individually monitor the SATS output phase voltages (line to neutral) at the CDP.

Note: Connect the leads to the line side of CDPX-M1 or CDPX-M2.

*

- * (4) Set the LDA to capture voltage disturbances on all phases as follows:

DRANETZ settings:

Input configuration = 4 WIRE / 3 PROBE
 RMS LIMIT ON_ALL
 V LOW RMS LIMIT ON_ALL
 V TRANSIENT MAGNITUDE ON_ALL
 V FREQ HZ SENSITIVITY ON_ALL

PARAMETER STATUS:

	A	B	C
V HIGH RMS LIMIT	ON	ON	ON
V LOW RMS LIMIT	ON	ON	ON
V TRANSIENT MAGNITUDE	ON	ON	ON
V FREQ HZ SENSITIVITY	ON	ON	ON

(5) Re-energize the SATS de-energized in paragraph 533c(2). Do not reload the SATS at this time. Ensure the LDA monitoring is turned on (write down the number of events).

d. Detailed Procedure. Perform the following procedure to verify the switching time of the SATS.

(1) Verify the Phase Status indicator is green indicating Source 1 and 2 are in phase. If the Phase Status indicator is red, determine and correct the cause of the out of phase condition before proceeding.

(2) Verify the SATS being tested is operating in Static Mode on Source 1 and Auto Retransfer is disabled.

(3) Perform a manual static transfer from Source 1 to Source 2. Verify the SATS transfers to the selected source.

(4) Using the information provided by the LDA, verify the transfer time is within tolerance in chapter 3 paragraph 308c. Label and retain waveform data (hard or soft copy).

(5) Perform a manual static transfer from Source 2 to Source 1. Verify the SATS transfers to the selected source.

(6) Using the information provided by the LDA, verify the transfer time is within tolerance in chapter 3 paragraph 308c. Label and retain waveform data (hard or soft copy).

(7) Perform a manual transfer from Source 1 static to Source 1 bypass. Verify a make before break or close transition occurred by the absence of a disturbance event on the LDA.

(8) Perform a manual transfer from Source 1 bypass to Source 1 static. Verify a make before break or close transition occurred by the absence of a disturbance event on the LDA.

(9) With the SATS on Source 1 static mode, open the PDU breaker which feeds Source 1 of the SATS. Verify a transfer to Source 2 static occurred.

*

- * (10) Using the information provided by the LDA, verify the transfer time is within tolerance in chapter 3 paragraph 308c. Label and retain waveform data (hard or soft copy).
- (11) Close the PDU output breaker to restore Source 1 to the SATS.
- (12) With the SATS on Source 2 static mode, perform a manual transfer from Source 2 static to Source 2 bypass. Verify a make before break or close transition occurred by the absence of a disturbance event on the LDA.
- (13) Perform a manual transfer from Source 2 bypass to Source 2 static. Verify a make before break or close transition occurred by the absence of a disturbance event on the LDA.
- (14) With the SATS on Source 2 static mode, open the PDU breaker which feeds Source 2 of the SATS. Verify a transfer to Source 1 static occurred.
- (15) Using the information provided by the LDA, verify the transfer time is within tolerance in chapter 3 paragraph 308c. Label and retain waveform data (hard or soft copy).
- (16) To disconnect the LDA, de-energize the SATS using the OWS Maintenance Mode functions. Remove the LDA test leads from the CDP main breaker.
- (17) Re-energize, but do not reload the SATS using the OWS Maintenance Mode.
- (18) Prior to reloading the SATS, verify the SATS is switched to the same source as the SATS currently supporting the critical load to prevent paralleling of UPS2 and UPS3 during the PMCS reloading process.
- (19) At the OWS, reload the SATS using the Maintenance Mode functions. Verify the PMCS reloads the affected SATS and return the Critical Group control back to Auto.
- (20) Reconfigure the SATS back to normal configuration (for example, SATXA to Source 1 static mode and SATSXB to Source 2 static mode).

534-550. Reserved.

*

Section 2. Other Maintenance Tasks Procedures

551-575. Reserved.

Section 3. Special Maintenance Procedures

576-599. Reserved.

Appendix 1. Certification Requirements

* A-1. System and Subsystem Certification.

System and subsystem certification is event based and relies on independent judgment about the quality and scope of specific advertised services being provided to a user. Event based certification ties the certification judgment to the decision to place a system or subsystem into service.

a. ATO personnel with certification authority must perform event based system and subsystem certification. The following events define when certification is required, regardless of whether it affects a certification parameter:

- (1) Prior to commissioning.
- (2) Upon request following aircraft accident/incidents.
- (3) Following adjustment to any certification parameter regardless of whether an interruption was required.
- (4) Prior to restoration following any flight inspection requiring on-site personnel.
- (5) Prior to restoration following any modification.
- (6) Prior to restoration following any maintenance task that required an interruption or would have required an interruption to a facility without redundancy.
- (7) Prior to restoration following any corrective maintenance activity required to restore a facility to operation.

b. System and subsystem certification is not required when a facility is restored to operation by restoration of power, initialization, or reset, and no other action was taken.

c. Some NAS systems contain user interface controls that can cause a certification parameter to be adjusted beyond its tolerance or limit. Such adjustments will not void the certification.

A-2. General.

a. This appendix defines the requirements for certification of the TRACON facility's DRPDS electrical equipment. Certification shall be performed on an event basis. Certification should be coordinated with local facility air traffic management and accomplished in conjunction with risk assessment and risk mitigation. The requirement for certification is defined in Order 6000.15. The DRPDS operation and configuration shall be verified in accordance with chapter 4 paragraph 403b of this handbook just prior to performing certification. Reference TI 6480.1, volumes 7 and 9 for SATS and PMCS operating instructions. Reference Commercial off the Shelf (COTS) Manual volume 6 for UPS operating instructions. *

* **b.** The DRPDS operator must review the entire certification procedure prior to initiating any portion of it. If a DRPDS service fails to meet a certification parameter requirement as identified in Table A-1, DRPDS Power System, of this appendix, the certification shall be secured and the DRPDS shall be restored to a reduced service configuration and verified by a DRPDS system specialist or DRPDS second level engineering support. The DRPDS certification shall continue after any failures are corrected and until all certification parameters are within requirements.

c. The DRPDS certification focuses on two provided services. First, the certification evaluates UPS, engine generators, and STS equipment operation in order to provide continuous power to the critical load. The second part evaluates the UPS's capability to provide conditioned power to the critical load. Both services shall be provided concurrently to the critical load.

d. Certification can be performed piecewise as required to meet power system availability requirements imposed by facility management. Although EG operation is required to support continuous power certification, UPS and SATS certification can be performed on utility. Critical Distribution Panelboards (CDPs) that are not immediately supporting SATS or UPS certification can be returned to a normal line-up to maximize load diversification.

Note: Certification should be coordinated and accomplished in conjunction with risk assessment and risk mitigation.

A-3. Certification Procedure.

*

a. Unload SATS on "A" side in accordance with the following steps.

(1) Set or verify the DRPDS configuration in accordance with chapter 4 paragraph 403b of this handbook.

(2) Configure SATS 1 through 4 (A and B) to static source 2.

* **Note:** Step A-2a(2) configures the SATS to allow each CDP side to receive power from the same UPS source (for example, UPS 3). During unload SATS operations that are initiated at the PMCS OWS, the PMCS will prevent disturbing power to downstream loads by automatically hot cross tying (close transition) the downstream CDP prior to unloading the selected SATS. Configuring the SATS as described in step A-2a(2) minimizes the potential for losing both the A side and the B side UPS should a transient occur while the CDP is in a hot crosstie configuration on UPS power.

*

*

(3) Individually unload SATS 1A, 2A, 3A and 4A from the PMCS OWS (rotate critical loads to DRPDS B side SATS while isolating the A side SATS).

(4) Verify that SATS 1B, 2B, 3B and 4B are operating properly on source 2 with source 1 and 2 available.

(5) Configure SATS 1A, 2A, 3A and 4A back to static source 1.

* **b.** Connect a Line Disturbance Analyzer (LDA) to SATS 1A as directed by the setup procedures provided in paragraph A-3 or configure the Powerlogic Circuit Monitor (CM4000) associated with SATS 1A as directed by the setup procedures provided in paragraph A-4. Both methods are acceptable and the method used is solely determined by local procedures or technician preference.

c. Transfer DRPDS loads to the PSG in accordance with chapter 4 paragraph 408a(1).

(1) Verify that all engines start and that the PMCS automatically connects SWGR 1 and SWGR 2 to generator power.

(2) Verify that sufficient engine capacity powers the DRPDS.

(3) Verify that all UPSs go to BATTERY when 1M1 and 2M1 open.

(4) Record UPS load, battery % capacity or minutes displayed on the UPS GUI.

(5) Verify that battery capacity is sufficient (reference chapter 3, paragraph 303f(8)).

(6) Verify that all UPSs go back to NORMAL mode after the transfer to EG power is complete.

(7) Verify that there are no disturbances recorded on the LDA or CM4000.

(8) Label and retain data (hard or soft copy) in the facility reference data (FRD).

d. Verify that UPS 2 is operating in NORMAL mode at rated voltage and frequency (reference chapter 3, paragraphs 303a(9), 303a(10), 303a(15) and 303c(4)) with no active alarms.

e. Manually transfer UPS 2 to BYPASS.

(1) Verify that a make before break or closed transition is recorded on the LDA or CM4000 (reference chapter 3, paragraph 303e(2)).

(2) Label and retain waveform data (hard or soft copy) in the FRD.

f. Manually transfer UPS 2 to NORMAL.

(1) Verify that a make before break or closed transition is recorded on the LDA or CM4000 (reference chapter 3, paragraph 303e(2)).

*

- * (2) Label and retain waveform data (hard or soft copy) in the FRD.
- g.** Perform a protective transfer of UPS 2 to BYPASS by performing the following:
 - (1) Isolate UPS 2's battery by opening UPS2's battery contactor or disconnect switches.
 - (2) Open input breaker CB1 at UPS 2.
- h.** Verify that UPS 2 transfers to bypass.
 - (1) Verify that the transfer time captured on the LDA or CM4000 is within the tolerance listed in chapter 3, paragraph 303e(1).
 - (2) Label and retain waveform data (hard or soft copy) in the FRD.
 - (3) Close UPS 2's input breaker CB1.
 - (4) Close UPS 2's battery contactor or disconnect switches.
- i.** Evaluate the UPS performance.
 - (1) Review UPS History Log and verify that no failures occurred during operations.
 - (2) If the UPS does not operate properly in steps A-2e through A-2k(1), UPS repairs should be made before continuing the system certification procedure.
- j.** With UPS 2 in Bypass mode, perform steps A-2.d through A-2.i substituting UPS 1 for UPS 2.
- k.** Return UPS 1 and 2 to Normal mode.
- l.** Configure the SATS selected in A-2b for STATIC mode and AUTOMATIC operation with auto retransfer disabled.
- m.** Manually transfer the selected SATS from sources 1 to source 2 in STATIC mode.
 - (1) Verify that the SATS transfers to the selected source and that the transfer time is within the tolerance listed in chapter 3, paragraph 308.
 - (2) Label and retain waveform data (hard or soft copy) in the FRD.
- n.** Manually transfer the selected SATS from source 2 to source 1 in STATIC mode.
 - (1) Verify that the SATS transfers to the selected source and the transfer time is within the tolerance listed in chapter 3, paragraph 308. *

- * (2) Label and retain waveform data (hard or soft copy) in the FRD.
- o.** Manually transfer the selected SATS from source 1 static to source 1 bypass.
 - (1) Verify the transfer time is within the tolerance listed in chapter 3, paragraph 308b(2).
 - (2) Label and retain waveform data (hard or soft copy) in the FRD.
- p.** Manually transfer the selected SATS from source 1 bypass to source 1 static.
 - (1) Verify the transfer time is within the tolerance listed in chapter 3, paragraph 308b(2).
 - (2) Label and retain waveform data (hard or soft copy) in the FRD.
- q.** With the selected SATS on source 1 in static mode, open the PDU output breaker that feeds source 1 of the selected SATS.
 - (1) Verify that the SATS transfers to the available source, and that the transfer time is within the tolerance listed in chapter 3, paragraph 308b(1).
 - (2) Label and retain waveform data (hard or soft copy) in the FRD.
- r.** Close the PDU output breaker that feeds source 1 of the selected SATS. Verify sources 1 and 2 are available and the SATS remains on source 2.
- s.** With the selected SATS on source 2 in static mode, open the PDU output breaker that feeds source 2 of the selected SATS.
 - (1) Verify that the SATS transfers to the available source and that the transfer time is within the tolerance listed in chapter 3, paragraph 308b(1).
 - (2) Label and retain waveform data (hard or soft copy) in the FRD.
- t.** Close the PDU output breaker that feeds source 2 of the selected SATS. Verify sources 1 and 2 are available and the SATS remains on source 1. Label and retain waveform data (hard or soft copy) in the FRD.
- u.** Evaluate the selected SATS performance. If the SATS under test does not operate properly in steps A-2o through A-2ae, repairs should be made before continuing the system certification procedure.
- v.** If using an LDA at the PMCS OWS, de-energize the SATS evaluated in step A-2u.
 - (1) Disconnect the LDA connected in step A-2b.
 - (2) Re-energize the selected SATS from the PMCS OWS.

*

- * **w.** Perform step A-2b for SATS 2A.
- x.** Perform steps A-2l through A-2v for SATS 2A.
- v.** Perform step A-2b for SATS 3A.
- z.** Perform steps A-2l through A-2v for SATS 3A.
- aa.** Perform step A-2b for SATS 4A.
- ab.** Perform steps A-2l through A-2v for SATS 4A.
- ac.** Reload “A” side SATS in accordance with the following three steps.
 - (1) Verify or carefully set each SATS (1 through 4 A and B) to source 2 static.

Note: Paragraph A-2ac(1) configures the SATS to allow each CDP side to receive power from the same UPS source for example, UPS 3). During unload SATS operations that are initiated at the PMCS OWS, the PMCS will prevent disturbing power to downstream loads by automatically hot cross tying (close transition) the downstream CDP prior to unloading the selected SATS. Configuring the SATS as described in step A-2ao(1) minimizes the potential for losing both the A side and the B side UPS should a transient occur while the CDP is in a hot crosstie configuration on UPS power.
 - (2) Individually re-load SATS 1A, 2A, 3A and 4A from the PMCS OWS.
 - (3) Verify that the DRPDS is stable with acceptable power from UPS 2 and UPS 3 at each SATS.
- ad.** After the DRPDS is stable, individually unload B side SATS by performing the following:
 - (1) Verify or carefully set each SATS (1 through 4, A and B) to source 2 static.
 - (2) Carefully unload SATS 1B, 2B, 3B and 4B from the PMCS OWS (switch all critical loads to side A while isolating side B).
 - (3) Verify that SATS 1B, 2B, 3B and 4B are operating properly on source 2 with sources 1 and 2 available.
 - (4) Verify that SATS 1A, 2A, 3A and 4A are operating properly on source 2 with sources 1 and 2 available.
 - (5) Carefully set each A side SATS (1A, 2A, 3A and 4A) to source 1. *

- * **ae.** Perform step A-2b for SATS 1B.
- af.** Perform steps A-2d through A-2i for UPS 3.
- ag.** Return UPS 3 to NORMAL mode.
- ah.** Perform steps A-2l through A-2v for SATS 1B.
- ai.** Perform step A-2b for SATS 2B.
- aj.** Perform steps A-2l through A-2v for SATS 2B.
- ak.** Perform step A-2b for SATS 3B.
- al.** Perform steps A-2l through A-2v for SATS 3B.
- am.** Perform step A-2b for SATS 4B.
- an.** Perform steps A-2l through A-2u. (For example, leave the LDA connected to SATS 4B).
- ao.** Return DRPDS loads to utility in accordance with (IAW) chapter 4, paragraph 408a.
 - (1) Verify that the DRPDS is operating IAW chapter 4, paragraph 403b.
 - (2) Verify that there are no disturbances recorded on the LDA or CM4000.
- ap.** If LDA is used, perform step A-2v for SATS 4B.
- aq.** Re-load SATS 1B, 2B, 3B and 4B in accordance with the following steps.
 - (1) Carefully set each SATS (1 through 4 A and B) to static source 1.

Note: Step A-2ad(2) configures the SATS to allow each CDP side to receive power from the same UPS source (for example, UPS 3). During unload SATS operations that are initiated at the PMCS OWS, the PMCS will prevent disturbing power to downstream loads by automatically hot cross tying (close transition) the downstream CDP prior to unloading the selected SATS. Configuring the SATS as described in step A-2ad minimizes the potential for losing both the A side and the B side UPS should a transient occur while the CDP is in a hot crosstie configuration on UPS power.

- (2) Individually re-load SATS 1B, 2B, 3B and 4B from the PMCS OWS.

*

- * (3) Carefully set each of the B side SATS to source 2.
- (4) Verify that the DRPDS is stable with acceptable power from UPS 2 and UPS 3 at each SATS.
 - ar. Record the certification results.
 - as. Repair equipment that does not pass certification parameter requirements. After repairing equipment, re-perform failed certification steps.

A-4. Line Disturbance Analyzer (LDA) Setup Procedure.

- a. Select and de-energize SATS 1A from the PMCS OWS.

WARNING: Use local lockout/tagout procedures when energizing, startup, or release of energy can occur. This is necessary to make sure that other personnel cannot start the power source during maintenance. Shock hazards can kill. Such procedures are a requirement from the latest version of Order 3900.19, FAA Occupational Safety and Health.

- b. Connect an LDA and a voltmeter as follows to the SATS de-energized in step A-3a. *

(1) Connect the LDA (Dranetz 4300 or equivalent) voltage leads to individually monitor the SATS output phase voltages (line to neutral) at the CDP.

Note: Connect at the line side of the main breaker.



Figure A-1. Dranetz Connection

(2) Set the LDA to capture voltage disturbances on all phases as follows:

DRANETZ settings:

Input configuration = 4 WIRE / 3 PROBE

THRESHOLD SETUP :

	A	B	C
V HIGH RMS LIMIT	122.0	122.0	122.000
V LOW RMS LIMIT	116.0	116.0	116.000
V TRANSIENT MAGNITUDE	50.0	50.0	50.000
V FREQ HZ SENSITIVITY	0.5	0.5	0.5

WAVE CAPTURE STATUS:

V HIGH RMS LIMIT ON_ALL

V LOW RMS LIMIT ON_ALL

V TRANSIENT MAGNITUDE ON_ALL

V FREQ HZ SENSITIVITY ON_ALL

PARAMETER STATUS:

	A	B	C
V HIGH RMS LIMIT	ON	ON	ON
V LOW RMS LIMIT	ON	ON	ON
V TRANSIENT MAGNITUDE	ON	ON	ON
V FREQ HZ SENSITIVITY	ON	ON	ON

- * c. Re-energize the SATS de-energized in step A-3a. Ensure that the LDA monitoring is turned on (remember the number of events).

A-5. Powerlogic Circuit Monitor (CM4000) Setup Procedure.

a. At the Operator Workstation (OWS), perform the following.

(1) Start the SMS-3000 Server by clicking on the SMS-3000 SERVER button on the OWS Graphics Index GUI screen. Enter the site specific username and password.

Note: The default username and password is *master*.

(2) Start the SMS-3000 Client by clicking on the SMS-3000 CLIENT button on the OWS Graphics Index Screen. Enter the site specific username and password at the login prompt.

Note: The default username and password is *master*.

(3) Verify the SMS-3000 Client begins its startup sequence. Once the sequence is done, verify the DRPDS system is online as indicated on the lower right corner of the client window.

(4) To open the DRPDS system, click on FILE in the upper menu selections. From the File drop down menu, click on OPEN SYSTEM. From the System window click on DRPDS and then click OPEN.

(5) To verify the disturbance parameters of the CM4000 installed on the SATS, first click on SETUP in the upper menu selections. From the Setup drop down menu, click on DEVICES/ROUTING.

(6) The Setup Device/Routing window appears. From the Devices Defined list, scroll down and click on the applicable SATS CM-4000 (for example, SATS2A CM4000).

(7) On the right hand side of the Setup Devices/Routing window, click on CONFIGURE.

(8) A Setup Device – SATSXX CM-4000 window appears. Click on the Onboard ALARMS/ EVENTS tab.

(9) In the Waveshape folder, click on WAVESHAPEVLN. Verify the following selections and setpoints.

- (a) Enable - Selected
- (b) Threshold = 5
- (c) Upper Limit = 15
- (d) Enable Setpoint Learning - NOT selected
- (e) Priority - Priority 1 (High)
- (f) Data Logs - None selected

*

- * (g) Disturbance WFC – Selected
- (h) Adaptive WFC – NOT selected

(10) If no changes were made, click CLOSE to exit. If changes were made to any of the above setpoints or selections, click on the UPDATE button to send the changes to the CM-4000. A warning will appear informing the user the CM-4000 will perform a reset during the update process – Click YES to proceed.

(11) Repeat steps A-4a(5) through A-4a(10) for the CM4000 installed on each SATS scheduled to be tested.

(12) To retrieve a waveform, at the OWS, click on DISPLAY in the upper menu selection of SMS-3000.

(13) From the display drop down menu, click on WAVEFORM PLOTS. The Select Waveform Source window appears. Expand the All Devices folder and locate the applicable SATS CM4000 and click on it. Then click OK.

(14) The Acquire Waveform window appears. Expand the Onboard folder and then expand the Disturbance Waveform folder. Locate the file with the corresponding date/time as the manual transfer performed in step A-4a(4) and click on it. Then click OK to upload the file. If a corresponding file does not exist, verify the time and date is correctly set on the CM4000. If the time and date are correctly set, re-verify the disturbance parameters.

(15) Once the upload is complete, a 12-Cycle Waveform appears. Click on the “3” icon on the waveform toolbar to display all three phases simultaneously. To display only the voltage waveform, double click on the Voltage label above the graph. Locate the disturbance in the waveform using the zoom function (magnifying glass icons). Once the disturbance is found, verify the switch time is within the tolerance provided in Chapter 3 of this order.

(16) To save a copy of the waveform for future reference, click on the “E” icon on the waveform toolbar. An Export Waveform Format window appears. Select OTHER (SELECTED GRAPH) and then click OK. An Exporting Voltage window appears. Select JPG under Export. Select FILE under Export Destination and then click BROWSE. The Save As window appears. Choose the desired location (for example, My Documents) and create an applicable file name (for example, SATS1A_ManSW_S1toS2) and then click SAVE. Click EXPORT on the Exporting Voltage window to save the waveform to the desired location. Close the waveform and return to the SATS.

*

Appendix 1. Certification Requirements

Table A-1. DRPDS Power System

*

Advertised Service	Certification Parameters	Reference Paragraph
b. Continuous Power	(1) UPS Operation	
	a. Manual transfer normal to bypass	303e(2)
	b. Manual transfer bypass to normal	303e(2)
	c. Protective transfer to bypass	303e(1)
	d. Battery bank capacity	303f(8)
	(2) PMCS response to simulated Outage	
	a. EG capacity during PSG operation	Maintain 2 engines operating (minimum)
	b. Transfer DRPDS to PSG	408a
	c. Critical Bus	No disturbance recorded on LDA or CM4000
	d. Transfer DRPDS to utility	408a
	e. Critical Bus	No disturbance recorded on LDA or CM4000
	(3) Transfer of SATS	
	a. Manual static transfer (in phase)	308c
b. Protective static transfer (in phase)	308bc	
c. Static to bypass transfer	308c	
c. Conditioned Power	(1) UPS Output Voltage	303d(1)
	(2) UPS Output Frequency	303d(4)

Certification Based on Events: Events are defined in Order 6000.15 and are provided only as reference data of appendix 1, paragraph 1 of this order.

*

Person Responsible for Certification: Airway transportation system specialist (ATSS) with certification authority

Certification Entry in Facility Maintenance Log: CPDS/DRPDS certified

CHANGE

**U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION**

**ORDER
JO 6480.22
CHG 1**

Air Traffic Organization Policy

Effective Date:
11/02/2010

Implementation
Date:

03/05/2011

SUBJ: Maintenance of Dual Redundant Power Distribution Systems
(DRPDS) Facilities

1. Purpose. This change transmits revised pages to Order JO 6480.22, Maintenance of Dual Redundant Power Distribution Systems (DRPDS) Facilities. This directive implements Configuration Control Decision (CCD) No. N32350, DRPDS Maintenance Handbook JO6480.22 Page Change to include L3 Static Switches and Certification update.

2. Who This Change Affects. This document requires actions by the Airway Transportation System Specialist (ATSS) at operational facilities with Facility, Service, and Equipment Profile (FSEP) equipment: CPDS.

a. For electronic copies, use the Technical Library website at http://nas.amc.faa.gov/technical_library/index.jsp.

b. The ATSS must keep accurate FSEP records and Logistics Inventory System (LIS) addresses to receive printed copies. Printed copies are mailed to the ATSS at operational facilities with an accurate FSEP record using the LIS mailing address per Order 6000.5D, Facility, Service, and Equipment Profile (FSEP).

c. To update LIS information, visit this link: <http://impart.faa.gov/impart/home.html>.

d. The Periodic Maintenance/Certification Scheduling (PMS) database is maintained by the Office of Primary Responsibility (OPR). The release of this document notifies the field of an update to the Remote Monitoring and Logging System (RMLS) National PMS database. An RMLS template will be available to the field for remote maintenance logging in approximately five working days after release of this document.

3. Risks.

a. In compliance with the latest edition of Orders 1100.161, Air Traffic Safety Oversight and JO 1000.37, Air Traffic Organization Safety Management System (SMS) all NAS changes require an SRM assessment prior to delivery. This applies to all products developed under this order.

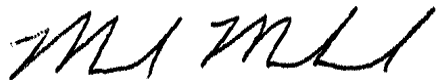
b. The Safety Risk Management Report is available at: http://nas.amc.faa.gov/technical_library/browse?type=mtd&file=6480_22_mthb_chg1_srmrpt.pdf.

4. Disposition of Transmittal. Keep this change.

5. Implementation Date. The implementation date is when all facilities nationwide must comply with these changes. The changes may be implemented anytime after the effective date, but must be implemented by the date located on the front of this document

PAGE CONTROL CHART

Remove Pages	Dated	Insert Pages	Dated
JO 6480.22			
Table of Contents			
iii thru vi	09/18/2007	iii	09/18/2007
		iv thru vi	11/02/2010
Chapter 3			
3-33 thru 3-38	09/18/2007	3-33 thru 3-35	11/02/2010
		3-36	09/18/2007
Chapter 4			
4-1 thru 4-8	09/18/2007	4-3 thru 4-5	11/02/2010
		4-6	09/18/2007
		4-7	11/02/2010
		4-8	09/18/2007
4-13 and 4-16	09/18/2007	4-13	11/02/2010
		4-14	09/18/2007
		4-15	11/02/2010
		4-16	09/18/2007
4-17	09/18/2007	4-17/4-18 (blank)	11/02/2010
Chapter 5			
5-1 and 5-2	09/18/2007	5-1	11/02/2010
		5-2	09/18/2007
5-25 thru 5-28	09/18/2007	5-25 thru 5-32	11/02/2010
Appendix 1			
A1-1 thru A1-12	09/18/2007	A1-1 thru A1-12	11/02/2010



for Jay Rupp,
Acting Director, Technical Operations, ATC Facilities