Critical Release Notice

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The content of this customer NTP supports the SN06 (DMS) and ISN06 (TDM) software releases.

Bookmarks used in this NTP highlight the changes between the baseline NTP and the current release. The bookmarks provided are color-coded to identify release-specific content changes. NTP volumes that do not contain bookmarks indicate that the baseline NTP remains unchanged and is valid for the current release.

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Black: Applies to new or modified content for the baseline NTP that is valid through the current release.

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Standard release 02.03 for software release SN06 (DMS) and ISN06 (TDM).

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297-1001–350

DMS-100 Family

Digital Switching Systems

Power and Grounding Routine Maintenance Manual

Applies to all BCS and PCL levels   Standard 02.02   August 1997

NORTEL
NORTHERN TELECOM

Digital Switching Systems

DMS-100 Family

Power and Grounding Routine Maintenance Manual

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Product release: Applies to all BCS/PCL levels
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August 1997

Standard 02.02 was issued to incorporate editiorial markup and customer feedback.

June 1994

Standard 02.01 was issued for the following reasons:

- to compose NTP 297-1001-350 in a new typographical style (restructured format).
- to comply with the generic design intent, terminology, and definitions of applicable Northern Telecom Corporate Standards and NTP 297-1001-156, *DMS-100 Family Power Distribution and Grounding Guide*
- to improve the composition, arrangement, and structure of the content
- to simplify and improve the text, figures, and tables.

March 1989

Standard 01.04 was issued for technical corrections and replaced all previous releases.

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About this document

This document contains maintenance procedures for checking the power and grounding installation for DMS-100 Family (DMS-100F) switch equipment.

The power-related maintenance procedures include various checks of the DMS battery plant and rectifiers, an operational exercise of the standby power system, and a method for removing and restoring power in an emergency situation.

Application of this document

It is written for personnel having responsibility for plant-equipment maintenance, installation, engineering, and planning. This guide is based upon the principles developed in Northern Telecom Corporate Standards.

More than one version of this document may exist. To determine whether you have the latest version of this document, check the release information in *DMS-100 Family Guide to Northern Telecom Publications*, 297-1001-001.

References

References listed as prerequisites are essential for understanding this document. Those listed as informative contain additional information, but are not essential.

More than one version of a document may exist. To determine whether you have the latest version of a document, check the release information in *DMS-100 Family Guide to Northern Telecom Publications*, 297-1001-001.

Some NTPs, supporting all PCLs and previous BCS releases, have not been updated with market specific information. NTPs with such an applicability statement and containing cross-references must be cross-checked against information in the DMS-10 and DMS-100 Cancellation Cross-reference Directory (297–8991–002)

Prerequisite references

- NTP 297-1001-156: *DMS-100 Family Power Distribution and Grounding Guide*
- TR-NWT-000295: *Bell Communications Research Technical Reference, Isolated Ground Planes; Definition and Application to Telephone Central Offices*
- *Rural Electrification Administration (REA) Telecommunications Engineering and Construction Manual*, Section 810: *Electrical Protection of Electronic Analog and Digital Central Office Equipment*
- ANSI/NFPA No. 70: *National Electrical Code—1990*
- CSA C22.1: *Canadian Electrical Code—1990*

Informative references

- NTP 297-1001-001: *DMS-100 Family Guide to Northern Telecom Publications*
- NTP 297-1001-120: *Equipment Identification*
- IS0X00: *Isolated Systems Grounding Topology*
- IS0X07ZA: *Digital Multiplex System AC Grounding*
- Federal Information Processing Standard (FIPS) Pub 94: *Guideline on Electrical Power for ADP Installations*
- ANSI/NFPA No. 75: *Protection of Electronic Computer/Data Processing—1989*
- ANSI/NFPA No. 78: *Lightning Protection Code—1989*

1 Introduction

The following definitions conform as closely as possible to those of the National Electrical Code (NEC) and the Canadian Electrical Code (CEC).

1.1 Definitions

battery return (BR):

A conductor that carries the –48 V return current. Although BR conductors are not grounding conductors, they are referenced to ground by the battery return reference (BRR) conductor of the serving dc power plant.

battery return reference (BRR):

A grounding conductor used to connect battery return to ground.

bonding:

The permanent joining of non-current carrying metallic parts to form an electrically conductive path, which ensures electrical continuity and the capacity to safely conduct any current likely to be imposed upon the path.

bonding network (BN):

A set of interconnected conductive structures that provides an electromagnetic shield for electronic systems and personnel at frequencies from dc to low rf. The term *electromagnetic shield* denotes any structure used to divert, block, or impede the passage of electromagnetic energy. In general, a BN need not be connected to earth, but all BNs considered in this document require an earth connection.

building principal ground (BPG):

The main point within a building at which the ground reference potential is established. The BPG is directly referenced to earth by such means as water pipes and/or electrodes driven into the earth.

common bonding network (CBN):

The principal means used for bonding and grounding inside a telecommunications building. It is the set of metallic components that are intentionally or incidentally interconnected to form the principal bonding network in a building. These components include: structural steel or reinforcing rods, metallic plumbing, ac power conduit, ac equipment grounding conductors, bonding conductors, and cable racks. The CBN is a mesh topology and is connected to the building grounding electrode system.

DMS-100 Family:

Designates the family of digital multiplexed switching systems which include the DMS-100, DMS-100/200, DMS-100 switching cluster, DMS-100 switching network, DMS-200, DMS-250, and DMS-300.

DMS single point ground (DMS SPG):

A single point where the framework bonding equalizer (FBE), the logic return equalizer (LRE), the serving ac equipment grounds (ACEG), the integrated collector bar (ICB), and the serving dc-power plant battery return reference (BRR) are connected to ground. The DMS SPG is usually one of the following types of busbars: building principal ground (BPG), floor ground bar (FGB), dedicated SPG bar, or a dedicated section of the serving dc-power plant battery return (BR) bar. In non-ISG configurations, the framework ground bus (rather than the FBE and LRE) is connected to the DMS SPG.

floor ground bar (FGB):

A copper bar on each floor of a building provided for equipment grounding. The FGB is connected to the VGR and effectively extends the BPG to each floor level.

framework bonding bar (FBB):

A copper bar used for bonding a DMS-100 frame to the FBE. The metal framework of each DMS frame is bonded to an FBB horizontally mounted above the frame.

framework bonding equalizer (FBE) bar:

A copper plate mounted on insulators and used in an ISG DMS system to bond DMS frames to ground. The FBE is preferably located close to PDC-00 and the equipment frames, and has a single connection to the DMS SPG. One Framework Bonding Bar (FBB) in each lineup is connected to the FBE. No other conductors are connected to the FBE.

framework ground bus:

A copper plate mounted on insulators and used in a non-ISG DMS system to provide ground reference to DMS frames. The framework ground bus is preferably located close to PDC-00 and the equipment frames, and has a single connection to the DMS SPG. It is the start and end point of a ground loop formed with conductors that interconnect the FBB of all the PDCs in the frame lineups. It is recommended that no other conductors are connected to the framework ground bus.

ground:

A metallic connection, whether intentional or accidental, between an electric circuit or equipment and the earth, or some conducting body that serves in place of the earth. Typically, a ground is a connection to earth obtained by a grounding electrode.

incidental ground:

An unplanned grounding connection.

isolated bonding network (IBN):

A bonding network that has a single point of connection to either the CBN or another IBN.

isolated system grounding (ISG):

The DMS grounding arrangement in which the equipment logic returns are connected to a plane that is separated internally from the framework ground. DMS-100F systems configured without ISG have equipment logic returns referenced internally to framework ground or battery return as required.

isolation:

The arrangement of parts of equipment, a system, or a facility to prevent uncontrolled electrical contact within or between parts.

logic return bar (LRB):

An isolated copper busbar used in DMS ISG frame-based systems. An LRB is installed parallel to the FBB. The first LRB of a DMS lineup is connected to the LRE. Subsequent LRBs in the same lineup are daisy chained to the first LRB. Each vertical logic return bar of an equipment row referenced to the LRE is connected to an LRB. The DMS core is treated as a separate equipment row with respect to the LRB. The LRB of the core is preferably located above the IOE frame.

logic return equalizer (LRE) bar:

An isolated copper plate with a single connection to the DMS SPG. Preferably, the LRE is located close to PDC-00 and the equipment frames. The first LRB of each lineup is connected to the LRE. No other connections are made to the LRE.

single point ground (SPG):
A single connection used to reference equipment or a system to ground. In an ideal IBN arrangement, no dc current flows through the single point connection unless a fault condition exists.

vertical ground riser (VGR):
A continuous conductor extending ground potential throughout the height of a multifloor building. The size of this conductor is either 750 kcmil or is equal to or larger than the largest conductor used for power distribution in the building. The FGBs on various floors are connected to the VGR.

vertical logic return bar:
A copper bar mounted vertically inside several types of DMS frames and used to reference the logic return to the LRB.

1.2 Abbreviations and acronyms

The following list is provided as a reference for a quick identification of abbreviations and acronyms used in this document.

ac: alternating current

BPG: building principal ground

BR: battery return

BRR: battery return reference

CBN: common bonding network

CEC: Canadian Electrical Code

CO: central office

CPDC: cabinetized power distribution center

CSA: Canadian Standards Association

dc: direct current

DMS: Digital Multiplex System

DMS SPG: DMS single point ground

FBB: framework bonding bar

FBE: framework bonding equalizer

FGB: floor ground bar

IBN: isolated bonding network

IGP: isolated ground plane

IGZ: isolated ground zone

ISG: isolated system ground

LR: logic return

LRB: logic return bar

LRE: logic return equalizer

LVD: low voltage disconnect

MGB: main ground bus (BCC terminology)

MGB: master ground bar (REA terminology)

NEC: National Electrical Code

NFPA: National Fire Protection Association

NTP: Northern Telecom publication

PDC: power distribution center

REA: Rural Electrification Administration

SPG: single point ground

TR: Technical Reference (Bell Communications Research)

UPS: uninterruptible power supply

VGR: vertical ground riser

VRLA: valve regulated lead acid

1.3 Cross reference of terms

Table 1–1 is a quick cross-reference of terms used by Northern Telecom, the BOCs, REA, and others.

Table 1–1
Cross reference of terms

NT	BOC	REA	OTHERS
battery return (BR)	–48 V return	N/A	– battery ground – dc return – positive discharge bus – power return
building grounding system	CO GRD	central office protection grounding	– COG – CO ground
building principal ground (BPG)	– OPGPB – PGP bus	master ground bar (MGB)	– COG – CO GRD bus – facility ground – OPGP – principal ground point (PGP) – reference point 0 – zero potential reference point
common bonding network (CBN)	integrated ground plane	integrated ground zone	– integrated ground system
DMS SPG	main ground bus (MGB)	master ground bar (MGB)	– main ground bar (MGB)
floor ground bar (FGB)	– CO GRD – CO ground bar – CO ground bus	floor bar	– COG – COGB – C.O. GRD
framework bonding bar (FBB)			
framework bonding equalizer (FBE) bar			– FG – framework ground – framework ground bus
isolated bonding network (IBN)	isolated ground plane	isolated ground zone (IGZ)	–isolated ground system (IGS)
logic return (LR)			– logic ground – signal ground
logic return bar (LRB)			– logic ground
logic return equalizer (LRE)			– logic ground
vertical ground riser (VGR)	– vertical equalizer – vertical riser		– C.O. ground riser – equipment ground riser – GRD riser – riser – VERT EQLR

2 Overview

The power distribution system supplies controlled and protected power to DMS switch equipment. The grounding system provides hazard protection for personnel and DMS equipment, and, within accepted standards, immunity from operational and transient phenomena.

2.1 DC power

Power from a –48 V power plant is fed through dual primary battery feeders (A feeders and B feeders) to the Power Distribution Centers (PDCs) of the DMS equipment. Each feeder consists of a –48 V conductor and an associated battery return (BR) conductor. The conductors of a feeder are of equal cross section and are run closely together.

Power from a PDC is distributed to DMS cabinets or frames through secondary battery feeders. Other required dc voltages, such as +5 V and –5 V, are obtained from 48-V powered dc/dc converters located within the DMS equipment shelves.

2.2 AC power

The ac-free version of the DMS switch is intended to maintain and enhance the integrity of the IBN by obviating the need for bringing external ac power to the switch. It provides internal inverters for feeding all ac powered loads within the switch as well as the convenience outlets. Center-aisle lighting provided with this version of the DMS switch is installed outside of the switch IBN and fed from general purpose ac distribution panels.

An earlier version of the DMS switch uses integrated lighting and is supplied with ac power from a general purpose distribution panel, an isolation transformer, a standalone inverter, or a UPS.

2.3 Grounding

The ISG version of the DMS switch is a grounding arrangement in which equipment logic returns are connected to a plane that is separated internally from framework ground. The logic return of non-ISG DMS switches is referenced internally to framework ground or battery return as required.

Within the overall IBN of the DMS switch, functional equipment blocks are configured as individual single-point-grounded entities. A functional block can be a shelf, frame, or a group of frames. Communication links between functional blocks and to the outside world generally use ac coupling techniques to ensure connectivity.

3 Power system maintenance

Operating companies should establish a formal routine maintenance plan for their DMS switch power systems. A maintenance plan is crucial in detecting and clearing potential power system faults before they affect service. The maintenance plan should include the following:

- routine battery maintenance
- visual checks and tests of the charging plant
- exercise of the standby power system operation
- visual checks and routine runs of the emergency alternator (if used).

This section provides the following:

- guidelines for inspecting the DMS switch power system
- various forms for recording potential power plant problems and for tracking the required corrective actions
- a list of checks and tests for each subsystem
- forms for recording the results of certain tests.

3.1 Preparations

Maintenance tasks require appropriate maintenance records and tools. These records and tools are enumerated in the following sections:

3.1.1 Maintenance records

The following maintenance records, or similar forms, should be included in the operating company office records. If any or all of these forms are not currently in the office records, reproduce the forms and include them in your office records.

- **Pilot cell voltage and specific gravity test record:** used to record voltage and specific gravity test results on battery plant pilot cells. See Figure 3–1.
- **Battery electrical and specific gravity measurements record:** used to record the results of the voltage and specific gravity tests on individual cells in the battery plant. See Figure 3–2.

- **Charging plant capacity and reserves data record:** used to list the normal and reserve capacity of the power plant rectifiers. See Figure 3–3.
- **Telephone number record:** used to list the telephone numbers of various support and emergency organizations related to the power plant. See Figure 3–4.
- **Standby engines—office loads and battery reserves record:** used to record normal office loads on the building ac power system and the reserve capacity of the battery plant. See Figure 3–5.
- **Power plant alarm check record:** used to record results of the power plant alarm check. See Figure 3–6.
- **Log sheet for stationary alternator routine engine runs:** used to record the results of the routine alternator engine runs for stationary alternators. See Figure 3–7.
- **Log sheet for mobile alternator routine engine runs:** used to list the results of the routine dispatch, set up, and running of mobile engine alternators. See Figure 3–8.
- **Standby power system exercise evaluation report:** used to record the major events in the standby power system exercise. See Figure 3–9.
- **Standby power system exercise control log:** used to record major events in the standby power system during the standby power system exercise. See Figure 3–10.
- **Standby power system exercise—stationary engine-alternator log:** used to log operating characteristics of the stationary engine-alternator during the standby power system exercise. See Figure 3–11.
- **Standby power system exercise—mobile engine-alternator log:** used to log the set-up and operation of the mobile engine-alternator during the standby power system exercise. See Figure 3–12.
- **Battery load test record:** used to record results of the battery load test performed as part of the standby power system exercise. See Figure 3–13.
- **Power plant maintenance action required:** used to list any required actions when performing power system maintenance checks. This form is not necessarily part of the maintenance records, but it provides a way of tracking maintenance actions on the power plant. See Figure 3–14. Because of the length of its title, this form will be referred to generically as the maintenance action record.

Figure 3–1
Sample pilot cell voltage and specific gravity test record

PILOT CELL VOLTAGE AND SPECIFIC GRAVITY TEST RECORD						
OFFICE:				DIVISION:		
CITY:				AREA:		
DISTRICT:				COMPANY:		
DATE	BATTERY STRING	PILOT CELL FLOAT VOLTAGE	BATTERY FLOAT VOLTAGE	PILOT CELL SPECIFIC GRAVITY*	ELECTROLYTE TEMPERATURE**	INIT’LS

* If VRLA batteries are used, ignore specific gravity readings or replace them with impedance/conductance readings.
** For a VRLA battery, measure the temperature at a terminal.

Figure 3–2
Sample battery electrical and specific gravity measurements record

BATTERY ELECTRICAL AND SPECIFIC GRAVITY MEASUREMENTS RECORD

CELL No.	VOLTAGE	SPECIFIC GRAVITY	CORRECTED SPECIFIC GRAVITY*	REMARKS
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				

Individual cell voltage should be: 2.17 + 0.05 / – 0.04 V/cell.
Are there any cells lower than 2.13V? YES____ NO____
Correct specific gravity should be: 1.210 + 0.015 / – 0.030.
Are there any cells lower than 1.180? YES____ NO____
* Ignore when VRLA batteries are used.

For VRLA batteries, use values specified by supplier.

Figure 3–3
Sample charging plant capacity and reserves data record

CHARGING PLANT CAPACITY AND RESERVES DATA RECORD			
OFFICE:		DIVISION:	
CITY:		AREA:	
DISTRICT:		COMPANY:	
TYPE OF PLANT	RECTIFIER CAPACITY	TOTAL LOAD IN AMPS	NUMBER OF RECTIFIERS AVAILABLE

Figure 3–4
Sample telephone number record

TELEPHONE NUMBER RECORD		
NAME	OFFICE	HOME
Level II Supervisor	________	________
Level I Supervisor	________	________
Power Technician	________	________
Alternative Power Technician	________	________
Emergency Engine Coordinator	________	________
Fire ________________		
Police ________________		
Commercial Supply Co. ________________		
Commercial Supply Telephone No.	________	________
Other	________	________
Doctor	________	________
Diesel Fuel Supplier	________	________
Address ________________		
________________		
MISCELLANEOUS	OFFICE	HOME
________________	________	________
________________	________	________
________________	________	________
________________	________	________

Figure 3–5
Standby engines—office loads and battery reserves record

STANDBY ENGINES—OFFICE LOADS AND BATTERY RESERVES RECORD

OFFICE	DIVISION
CITY	AREA
DISTRICT	DATE

#1: COMMERCIAL SUPPLY DATA

TOTAL ESSENTIAL LOAD IN KW	
COMMERCIAL SUPPLY CO.	TEL. NO.
VOLTAGE	No. OF PHASES

#2: OFFICES HAVING STATIONARY STANDBY-ALTERNATOR

MAKE	START AUTO OR MAN	TYPE GAS TURBINE DIESEL	CAP IN KW	FUEL TYPE	RUNNING TIME FULL TANK

#3: CENTRAL OFFICE LOADS AND BATTERY RESERVES

TYPE OF PLANT	TOTAL LOAD IN AMPS (highest load that has been recorded under emergency conditions)	BATTERY HRS RESERVE	MANUFACTURER TYPE OF CELLS AND LIST NO.	AGE (MFG DATE)

#4: OFFICES REQUIRING MOBILE EMERGENCY GENERATOR

CAPACITY REQUIRED	AVAILABLE BY TRUCK/TRAILER	STORAGE LOCATION	FUEL		FUEL CAP	TIME TO TRANSPORT & SET UP	RUNNING TIME FULL TANK
			GAS	DIESEL			

Figure 3–6
Sample power plant alarm check record

POWER PLANT ALARM CHECK RECORD						
OFFICE:				DIVISION:		
CITY:				AREA:		
DISTRICT:				COMPANY:		
TYPE ALARM (See Note)						
HIGH VOLTAGE	LOW VOLTAGE	RECTIFIER FAILURE	FUSE ALARM	DATE	INITIALS	REMARKS
Note: If used, audible and visual alarms, alarm cutoffs, high float alarms, and low float alarms are to be included in this alarm check.						

Figure 3–7
Sample log sheet for stationary alternator routine engine runs

LOG SHEET FOR STATIONARY ALTERNATOR ROUTINE ENGINE RUNS

OFFICE:______________________________

	MANUFACTURER	MODEL
ENGINE		
ALTERNATOR OR GENERATOR:		

KW RATING:____________________ FROM:_______________ TO:_______________

DATE AND TIME	AMBIENT TEMP	TEMP ENGINE	LUBE OIL PRESS	ENG. RPM	KW LOAD			CURRENT			VOLTAGE			HOURS RUN
					1	2	3	1	2	3	1	2	3	
Use the headings that apply.								TOTAL HOURS RUN TO DATE						

Figure 3–8
Sample log sheet for mobile alternator routine engine runs

LOG SHEET FOR MOBILE ALTERNATOR ROUTINE ENGINE RUNS

OFFICE:____________________ FROM:__________ TO:__________

DATE	TIME EMG ENGINE DSPCH	SIZE OF ENGINE DSPCH	TIME OF ENGINE CONND	TIME OF ENGINE DSCTD	TEMP ENGINE	OIL PRESS	ENG RPM	KW LOAD			CURRENT			VOLTAGE		
								1	2	3	1	2	3	1	2	3

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Figure 3–9
Sample standby power system exercise evaluation report

STANDBY POWER SYSTEM EXERCISE EVALUATION REPORT

LOCATION:____ DATE:_____________

LEVEL 1 SUPERVISOR:_____________________________

		+12V*	–24V*	–48V	+130V*	–130V*
1	FLOAT VOLTAGE IN VOLTS					
2	LOAD IN AMPS					
3	LOAD ON COMMERCIAL AC IN KILOWATTS	NORMAL_________			PEAK_________	
4	TIME DISCHARGE STARTED					
5	RELEASE VOLTAGE:					
6	END CELL CUT-IN TIME (IF END CELL INSTALLED)					
7	ALARMS RAISED	TYPE_________			LEVEL_________	
8	TIME ENGINE STARTED:____	CRANKING TIME:_________ TIME ENGINE STARTED:_________				
9	STANDBY ENGINE TRANSFER TIME (COMMERCIAL TO STANDBY)					
10	VOLTAGE REACHED					
11	BATTERY LOAD TEST RUN? (YES or NO)					

		PHASE 1	PHASE 2	PHASE 3
12	kW LOAD ON STANDBY ALTERNATOR	PHASE 1	PHASE 2	PHASE 3
	ESSENTIAL LOAD			
	BUILDING LOAD			
	TOTAL			

13	STANDBY ENGINE TRANSFER TIME (STANDBY TO COMMERCIAL)	
14	TIME FROM TRANSFER TO ENGINE STOP	
15	TIME TEST COMPLETED	

* IF PROVIDED

Figure 3–10
Standby power system exercise control log

STANDBY POWER SYSTEM EXERCISE CONTROL LOG

OFFICE:______________________________

LOCATION	TIME COMMERCIAL POWER		SIZE OF STANDBY ENGINE USED (KW)	NORMAL OFFICE LOAD (AMPS)		LOAD TRANSFERRED TO STANDBY ENGINE (AMPS)		BATTERY RESERVE				
	OFF	ON		ESSENTIAL	BUILDING	ESSENTIAL	BUILDING	12 V*	24 V*	48 V	+130 V*	–130 V*

* IF PROVIDED

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Figure 3–11
Standby power system exercise—stationary engine-alternator log

STANDBY POWER SYSTEM EXERCISE—STATIONARY ENGINE-ALTERNATOR LOG

OFFICE:______________________________

	MANUFACTURER	MODEL
ENGINE		
ALTERNATOR OR GENERATOR:		

KW RATING:____________________ FROM:_______________ TO:_______________

DATE AND TIME	AMBIENT TEMP	TEMP ENGINE	LUBE OIL PRESS	ENG RPM	KW LOAD			CURRENT			VOLTAGE			HOURS RUN
					1	2	3	1	2	3	1	2	3	
Use the headings that apply.								TOTAL HOURS RUN TO DATE						

Figure 3–12
Standby power system exercise—mobile engine-alternator log

STANDBY POWER SYSTEM EXERCISE—MOBILE ENGINE-ALTERNATOR LOG

OFFICE:______________________ FROM:__________ TO:__________

DATE	TIME EMG ENGINE DSPCH	SIZE OF ENGINE DSPCH	TIME OF ENGINE CONND	TIME OF ENGINE DSCTD	TEMP ENGINE	OIL PRESS	ENG RPM	KW LOAD			CURRENT			VOLTAGE		
								1	2	3	1	2	3	1	2	3

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Figure 3–13
Battery load test record

BATTERY LOAD TEST RECORD

LOCATION:______________________________ DURATION OF TEST:___________

DATE:___________

STRING #	CELL #	TERMINAL VOLTAGE AT START OF TEST	TERMINAL VOLTAGE AT END OF TEST

Figure 3–14
Power plant maintenance action required

POWER PLANT MAINTENANCE ACTION REQUIRED

OFFICE:______________________________ DATE:__________________

REQUESTED BY:________________________ PHONE No.:______________

ITEM	SUBSYSTEM	PROBLEM (DESCRIBE)	ACTION RECOMMENDED	GROUP OR PERSON RESPONSIBLE

PAGE:_________ OF:_________

3.1.2 Maintenance action record

The performance of power plant maintenance may reveal problems requiring maintenance action. These problems are recorded on the form for power plant maintenance action required (Figure 3–14). This form will be referred to frequently throughout this document. Because of the length of its title, this form will be referred to generically as the maintenance action record.

At the completion of the power plant maintenance job, when actions are recorded in the maintenance action record, the form should be submitted to the operating company maintenance group for further analysis and action. This form can also be filed in the office records for future reference.

3.1.3 Tools

DANGER
Battery hazard
Goggles, gloves, and apron are required when working in the battery room. Failing to use these safety items may result in injury to personnel.

The following tools are required to perform power system maintenance:

- flashlight
- voltmeter (capable of measuring 100 V dc or more)
- clamp-on ammeter (AWS DIGISNAP, Model DSA-2003, or equivalent)
- noise measuring set (dBrnC)
- oscilloscope (20 MHz or better)
- safety goggles
- rubber gloves
- acid-proof apron
- hydrometer suitable for measuring battery electrolyte specific gravity.

3.2 Power plant critical limits

To ensure proper operation of the DMS switch, the power plant must conform to certain limits regarding electrical noise and voltage drops throughout the power distribution system. The following limits on the power system should be verified.

- Voltage limits:

	MIN	MAX
At the battery terminal:	–44.75 V	–55.80 V
At the power plant discharge bus	–44.50 V	–55.80 V
At the input terminals of a PDC	–43.75 V	–55.80 V
At the input terminals of a frame load	–42.75 V	–55.80 V

- Noise limits: The maximum allowable voiceband noise measured at the battery terminals of any dc source where a DMS-100 circuit may be connected is 55 dBrnC. The higher frequency noise must not exceed 300 mV rms in any 3 kHz band between 10 kHz and 20 MHz.
- Step voltage changes: Shall not exceed 5 V at rate of change of 1 V/ms at the load side of the primary distribution fuse. Faster rates of change can be tolerated if the product of the step voltage magnitude and rate of change does not exceed 5 V^2/ms.

  Note: Step voltage changes may be caused by transients such as end cell switching, CEMF cell switching, float–equalize switching, and rectifiers being switched on or off.

Use the voltmeter, noise measuring set, and oscilloscope to measure the voltage levels throughout the power distribution system to verify that voltages are within the recommended limits.

Use the noise measuring set and oscilloscope to measure electrical noise, noise frequency, and voltage step change rates on the power leads.

WARNING
Grounding violations & incorrect readings
To avoid possible grounding violations and incorrect readings, use only DMS inverter power to power the oscilloscope. DO NOT use the grounding clip on the oscilloscope probe to ground the oscilloscope, as incorrect readings resulting from a possible ground loop may result. DO NOT allow the oscilloscope grounding clip to touch the power bus, as a short circuit may result that can severely damage the scope. Use vinyl tape, or some other means, to insulate the exposed grounding clip on the scope probe.

3.3 Power plant maintenance schedule

Recommended intervals for performing power system maintenance are shown in Table 3–1. These are recommended maximum intervals. If your local practices require smaller intervals, follow your local practices.

Table 3–1
Power plant maintenance schedule

INTERVAL	SUBSYSTEM	MAINTENANCE TASK	REFERENCE
Ongoing	Battery plant	Routine battery maintenance	Section 8 Battery equipment, and Table 3–3
Every month	Engine-alternator	Engine and starting system check	Section 3.9 Standby power system checks
Every two months	Engine-alternator	Routine engine run	Local practices
Every six months	Charging equipment	Inspection and test	Section 3.7 Charging equipment
Every year	Standby power system	Operational test	Section 3.11 Standby power system exercises
Every year	Battery plant	Load test	Section 3.11 Standby power system exercises
Every year	————	Miscellaneous power system checks	Section 3.12 Miscellaneous power plant checks

3.4 Power plant checks

Power plant checks consists of the following:

- power plant safety checks
- power plant fuses
- charging equipment checks
- battery equipment checks
- standby power system checks
- standby engine-alternator checks
- standby power system exercise
- miscellaneous checks

The power plant checks can be performed in any order and on a selective basis. While performing these checks, fill in appropriate maintenance records (Figures 3–1 through 3–13), as well as the maintenance action record (Figure 3–14).

Each check describes an item and the normal state or condition for the check. If an item being checked is found to be abnormal, record the following information in the maintenance action record:

- sequential number in ITEM field for future reference
- power plant subsystem affected in SUBSYSTEM field:
  - — charging plant
  - — battery plant
  - — standby power system.
- description of the problem in PROBLEM field
- description of the corrective action recommended in the ACTION REQUIRED field
- name of the person or group responsible for performing the corrective action.

Instructions for completing the remaining forms, as needed, are provided in the following paragraphs.

3.5 Power plant safety checks

Maintenance routines in power rooms present potentially hazardous situations due to the voltages and corrosive chemicals present. Adhere to strict safety practices to avoid personnel injuries such as battery acid damage to the eyes and acid or electrical burns to the body.

The following items are a minimum requirement to prevent or lessen bodily injuries and damage to personnel or property in battery equipped power rooms:

- 2 rubber-coated aprons
- 2 pairs of rubber boots
- 1 eyewash bottle or eye flush fountain
- 2 pairs of acid-proof, anti-splash gloves
- 2 pairs of protective goggles
- 2 lbs of bicarbonate of soda
- 1 flashlight
- insulated tools for work on batteries
- first aid kit
- first aid instructions
- list of emergency telephone numbers
- emergency communications system (telephone or 2-way radio)
- fire extinguisher, approved for use on chemical and electrical fires.

Check the battery room safety equipment for these items, which should be included in the battery room safety equipment stock. Record any deficiencies in the maintenance action record.

Allow no one to work in the power room alone. A second person should always be present to obtain emergency assistance in the event of an accident. Warning signs, which state that personnel in the battery room must be accompanied by at least one other person, should be posted at the battery room entrance and within the battery room.

3.6 Power plant fuse checks

Perform the following checks on the power plant fuses. Record any problems found in the maintenance action record.

- Check each fuse for the proper rating and type.
- Check the spare fuse racks to verify that spare fuses are available.
- Check the tool area to verify that cartridge-type fuse pullers are available.
- Check the fuse records to verify that they are current.
- Check the power distribution centers (PDCs) for proper fusing. The proper fuse size is 9/32-inch.
- Check the back of the PDC for excessive heat dissipation per DMS switch procedures.
- Check the back of the power plant for heat and loose connections.
- Check the operation of the fuse alarms to verify that they are functioning properly.

3.7 Charging equipment checks

Perform the following checks on the charging plant. Record any problems found in the maintenance action record.

- Check the rectifiers to determine if they are operating and load sharing within proper limits.
- With one rectifier removed from service, check the remaining rectifiers to verify that they can handle the load.
- Check the cable connections to the busbar for excessive heating.
- Check the rectifier failure alarms to verify that they are functioning properly.
- Check the office records to verify that the plant power meters are being calibrated annually.
- Check with the maintenance personnel to verify that they are monitoring the power alarms (refer to Table 3–2).
- Check the power plant equipment documentation to determine if the power equipment maintenance and owner manuals are readily available.

Table 3–2
Power plant data, monitored conditions

MONITORED CONDITION	RECOMMENDED ALARM CLASSIFICATION	
	MAJOR	MINOR
High Voltage. The plant output voltage has exceeded its permitted upper limit.	X	
Battery-on-discharge. The plant output voltage is below the open circuit voltage of the battery.	X	
Rectifier failure. A rectifier has failed.		X
Rectifier Major. Two or more rectifiers have failed.	X	
Low float. The float voltage is below the low float voltage setting of the plant.		X
High float. The float voltage is above the high float voltage setting of the plant.		X
Control fuse. A fuse that provides power to a dc power plant monitoring circuit has operated. This condition may mask a major alarm condition.	X	
One converter. If converters are used, a converter failure initiates a minor alarm, indicating that the plant is operating without a backup converter.		X
Converter major. If converters are used, a converter failure indicates one or more of the following conditions: low bus voltage, two converters shut down, or control fuse operation.	X	
Low voltage. The output voltage has fallen below the low-voltage limit setting of the plant.	X	
Low voltage disconnect. The output voltage has fallen below the disconnect level setting of the plant.	X	
Distribution fuse or circuit breaker. A distribution fuse or circuit breaker has disconnected power to a load. The LVD (if equipped) has been activated.	X	

3.8 Battery equipment checks

The battery equipment requires periodic maintenance to ensure optimum safety and performance. Battery maintenance consists of routine measurements, cleaning, and the assessment of individual cell conditions.

3.8.1 Maintenance intervals

The maintenance and routine frequency of VRLA batteries should be conducted in accordance with the manufacturer's guidelines for these batteries.

The care and maintenance of lead-acid batteries is discussed in the following paragraphs.

Recommended intervals for performing battery maintenance are shown in Table 3–3. These are recommended maximum intervals. If your local practices require smaller intervals, follow your local practices.

Table 3–3
Schedule of battery readings and work intervals

MAXIMUM INTERVAL	DESCRIPTION OF OPERATION	LOW-GRAVITY CELLS LIMITS	HIGH-GRAVITY CELLS LIMITS	REFERENCE
Weekly or each visit	Pilot cell and emergency cell voltage reading	2.17 + 0.05 / – 0.04 V/cell	Lead-calcium: 2.30 +/– 0.05 V/cell Lead-antimony: 2.25 +/– 0.05 V/cell	Figure 3–1
Weekly or each visit	Battery float voltage reading (See Notes.)	2.17 +/– 0.01 V/cell	Lead-calcium: 2.30 +/– 0.01 V/cell Lead-antimony: 2.25 +/– 0.01 V/cell	Figure 3–1
Weekly or each visit	Emergency cell specific gravity (See Notes.)			
1–1/2 months	Pilot cell specific gravity reading (corrected) (See Notes.)	1.210 + 0.015 / – 0.030	1.3000 + 0.015 /– 0.025	Figure 3–1
3 months	Individual cell voltage readings	2.17 + 0.05 / – 0.04 V/cell	Lead-calcium: 2.30 +/– 0.05 V/cell Lead-antimony: 2.25 +/– 0.05 V/cell	Figure 3–2
3 months	Inspect and clean if necessary			
6 months	Individual cell specific gravity readings	1.210 + 0.015 / – 0.030	1.30 00 + 0.015 / – 0.025	Figure 3–2
1 year	Average battery float voltage under varying voltage and load conditions. Calibration of power panel volt meter.	2.17 +/– 0.01 V/cell	Lead-calcium: 2.30 +/– 0.01 V/cell Lead-antimony: 2.25 +/– 0.01 V/cell	Figure 3–2
1 year	Water analysis			
As required	Electrolyte level			

Note 1: Record electrolyte temperature when taking voltage and specific gravity readings.
Note 2: For VRLA cells, the voltage limits should be within the values specified by the battery manufacturer.
***Note* 3**: Ignore references to emergency cells in power plants that are not using such cells.

3.8.2 Trouble conditions

Routinely evaluate the condition of each battery in the battery plant to determine if any maintenance action is required.

The following paragraphs describe the trouble conditions of lead-calcium and lead-antimony cells and batteries. The most common troubles with lead-calcium and lead-antimony cells are loose battery post connections, positive plate growth, battery post corrosion, and problems related to low electrolyte levels and high ambient temperatures.

3.8.3 Post connections

Loose battery post connections can result in high-resistance contacts. The high resistance can cause the connection to heat excessively, which can damage cable insulation and battery post bushings.

DANGER
Battery hazard
When using metallic tools on batteries, take great care to avoid possible personnel injury and equipment damage. Always use insulated tools on battery equipment.

Any loose battery post connections must be tightened to the manufacturer's specification. A torque wrench should be used to check the tightness of the battery post connections.

3.8.4 Positive plate growth

Positive plate growth is the expansion of the positive battery plate caused by oxidation of the lead, which causes the lead to change to lead dioxide. Lead dioxide occupies more volume than lead, resulting in lead plate expansion.

The problems resulting from positive plate growth can be seen by examining the construction of the battery as shown in Figure 3–15. As the positive plate expands, it eventually makes contact with the cell jar and begins to exert pressure on the jar wall. With further expansion, the battery jar bulges under the stress, and the force on the jar wall builds to the point where the cell jar cracks (Figure 3–16). The cracks in the cell jar then permit the battery electrolyte to escape.

Positive plate growth can progress enough to cause cell jar failure before the expected cell life of 20 years is reached. Regularly check any lead-calcium and lead-antimony cells that are 10 years old or older for signs of positive plate growth.

Positive plate growth is visible in transparent containers and may be gauged by eye. A cutaway view of the battery plates may be seen in Figure 3–16. Only positive plates are expected to grow. In new batteries, the positive plate edges do not project beyond the separator. As growth progresses, the plate edges will slowly grow out past the separators and finally touch the inner wall of the container. Positive plate growth will also occur in the vertical plane. In some designs, the positive plates will apply pressure on the cover or grow vertically downward and touch the plastic jar ridge used for positioning or supporting the negative plates. An estimate of positive plate growth can be made by comparing the position of the lower edge of the positive plates with the bottom of adjacent negative plates, which do not grow. A diagram of battery plates showing signs of positive growth can be seen in Figure 3–16.

Positive plate growth in hard-rubber containers can be detected when internal stresses have progressed to a point where the cover rises or the side bulges noticeably. Excessive cover-rise can break the container cover seal. If lateral plate growth is excessive, the container will bulge and may eventually crack and burst. To measure container bulge, place a straight edge along the container wall and measure the amount of protrusion from the plane formed by the container corner edges. Cover rise and bulging of containers must not be allowed to exceed 3/4 inch for larger cells, and correspondingly less for smaller cells.

When evaluating the condition of the batteries, be alert to detect crazed or cracked cell containers caused by positive plate growth. Order cell replacements before leaks occur. Acid leakage can cause short circuits and corrosion, which can create a potential fire hazard.

3.8.5 Post corrosion

Post corrosion is due to the creeping of electrolyte up the battery post and chemical reactions with lead and copper in the battery post and intercell connector. This corrosive action can cause high-resistance contacts and a heating up of the connection during heavy load conditions. For this reason, any post corrosion indicates that maintenance action is required. The extent of the maintenance action depends on the type of corrosion, which is indicated by its color.

White or brown post corrosion

White post corrosion is the formation of lead-sulfate, and brown post corrosion is the formation of lead-dioxide (see Figure 3–17). Although these types of corrosion do not indicate a serious condition, they do indicate a possible high-resistance connection. A battery post with these types of corrosion must be cleaned.

To properly clean the battery post, remove all traces of the corrosion and wash the connection with a damp cloth soaked in a mild sodium bicarbonate solution. After washing the connection, check the connection resistance by looking for any signs of connection heating. Excessive connection heating indicates a high-resistance connection. If there are no signs of excessive heating, apply a light coating of NO–OX–ID “A” or equivalent compound to the connection. If there are signs of excessive heating, disassemble, clean, and reassemble the connection using local procedures. Apply a light coating of NO–OX–ID “A” or equivalent compound to the connection.

Green or blue post corrosion

Green or blue corrosion is copper sulfate, which results from corrosion of the copper inner core of the intercell connector. This type of corrosion indicates failure of the lead jacket around the intercell connector. With this type of corrosion, the intercell connector must be replaced.

To properly replace the intercell connector:

1. Remove the affected intercell connector using local procedures.
2. Remove all traces of the corrosion from the battery post.
3. Wash the battery post with a damp cloth soaked in a mild sodium bicarbonate solution.
4. Apply a light coating of NO–OX–ID “A” or equivalent compound to the post.
5. Install a new intercell connector using local procedures.
6. Apply a light coating of NO–OX–ID “A” or equivalent compound to the post connection.

Figure 3–15
Typical internal parts of a battery

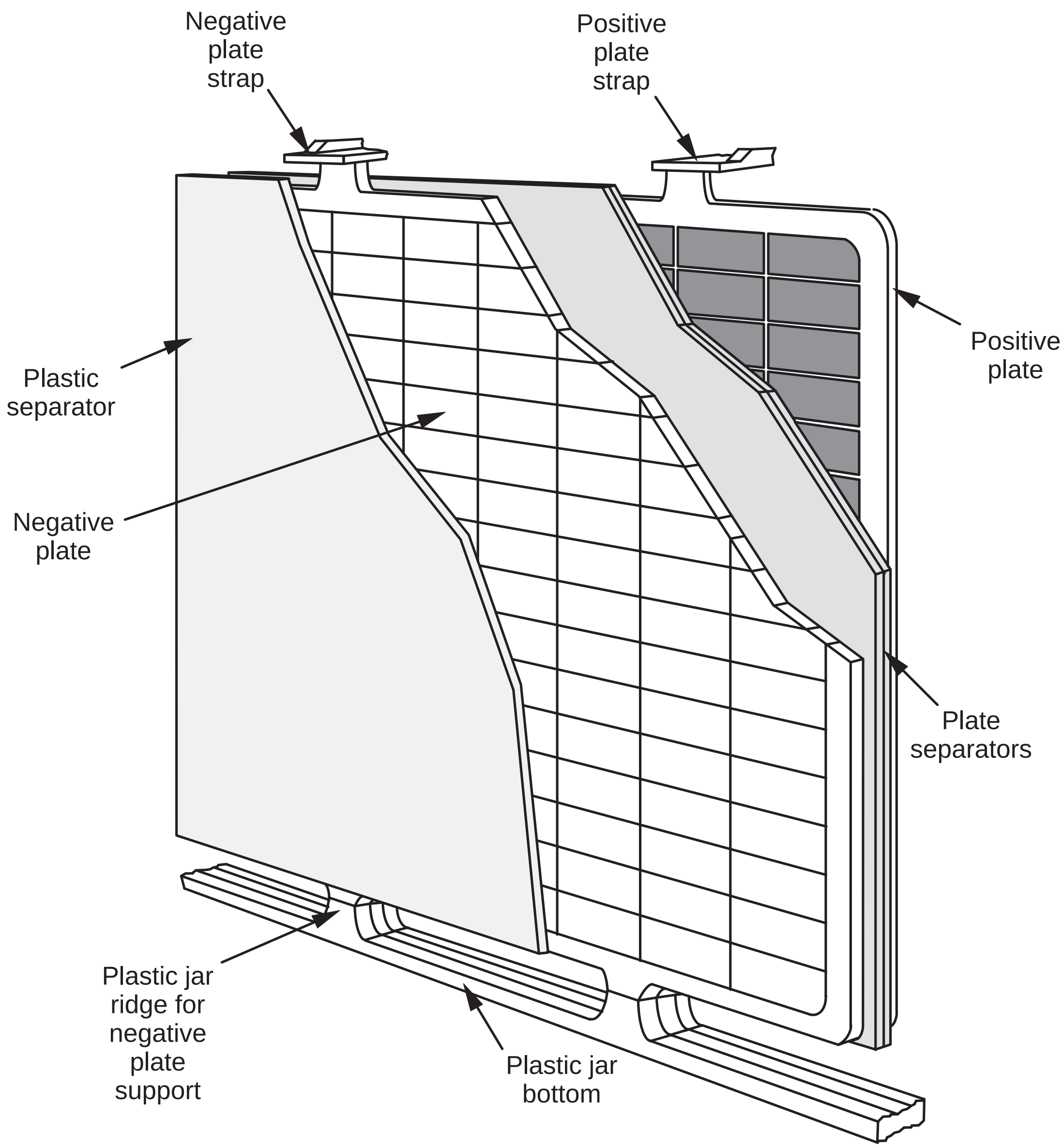


Figure 3–16
Positive plate growth

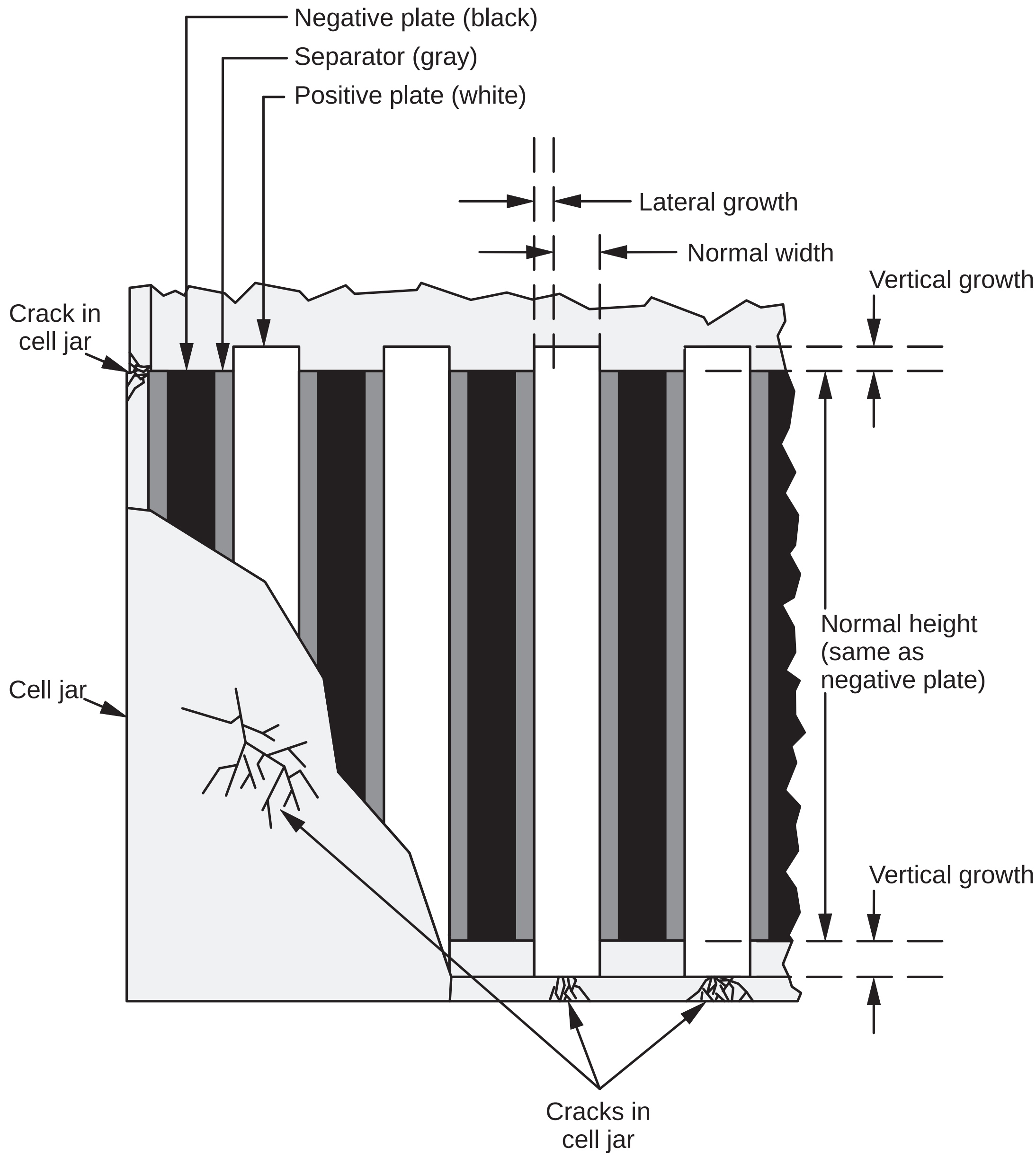
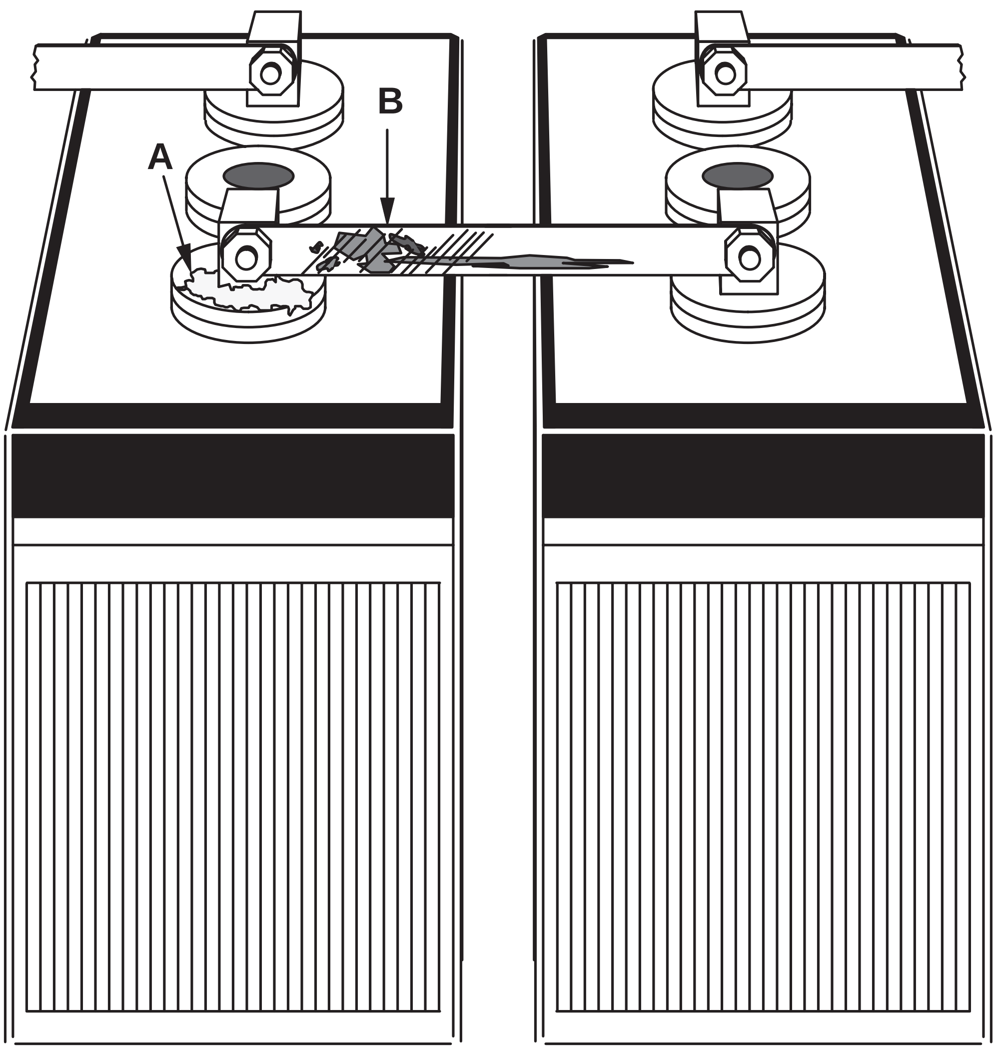


Figure 3–17
Battery post and intercell connector corrosion



A: POST CORROSION: Appears as brown lead-dioxide or white lead-sulfate. Cleaning and a light application of NO-OX-ID“A” or equivalent compound to the connections is all that is required.

B: INTERCELL CONNECTOR CORROSION: Appears as blue or green copper sulfate. This indicates that the electrolyte has penetrated the intercell connector lead jacket and is reacting with with the copper inner core. This intercell connector must be replaced.

3.8.6 Electrolyte level and temperature

Electrolyte level and temperature play an important role in the expected life of the battery.

At all times after initial charge, the level of electrolyte in any cell must be maintained as recommended by the battery manufacturer. Low electrolyte levels cause excessive gassing and twisting of plates.

If the electrolyte level of any cell is below the lower limit, add water approved for battery use to bring the electrolyte up to the recommended level. Refer to Water Analysis Report for information on water intended for battery use.

The recommended operating range of the ambient temperature is 65°F to 80°F (18°C to 26.7°C) to keep the electrolyte temperature at a safe level. High ambient temperatures reduce life expectancy. If operated at a temperature of 90°F (32.2°C) for two months per year, the battery life expectancy is reduced by 20 percent.

If the battery room ambient temperature is over 80°F (18°C) or below 65°C (27°C), check the battery room ventilation system and environmental control system and adjust as needed.

3.8.7 Water analysis report

To bring electrolyte up to the required level, use only distilled water, deionized water, or other water approved for storage battery use. To obtain approval for local water, have it analyzed by a local laboratory or the battery manufacturer. The sample should be one quart of local water in a clean polyethylene or glass container with a non-metallic closure. The label on each sample must contain the following information:

- name of operating company
- city or town and state
- date sample taken
- source of water supply.

Batteries damaged through use of impure water are usually void of any warranty by the maker. For this reason, the operating company should retain a permanent record of each water analysis report.

Deionized water that meets the requirements in Table 3–4 is satisfactory for battery use.

Table 3–4
Maximum allowable impurities in battery water

TYPE OF IMPURITY	PPM (mg/L)	PERCENT
Total solids	500	0.0500
Fixed solids	350	0.0350
Organic and volatile matter	150	0.0050
Chloride	25	0.0025
Iron	4	0.0004
Nitrates and nitrites	10/10	0.0010
Ammonia	5	0.0005
Manganese (NS 5553)	0.007	0.0000007
Manganese (NS 15544)	0.014	0.0000014

3.8.8 Avoiding battery trouble

To avoid costly trouble conditions, adhere to the following rules for good battery maintenance:

- Maintain the battery in a healthy state of charge with as little excess charge as possible. Maintain the correct float voltage values listed in Table 3–3.
- Maintain the electrolyte level between the HIGH and LOW marks by the addition of approved water.
- Keep the temperature of the electrolyte within acceptable, specified limits.
- Keep the battery clean.
- Replace cells where bulging, cracking, leaking, or other physical defects warrant replacement.

WARNING
Battery integrity
New cells often cannot be inserted in an old battery string. Follow the manufacturer recommendations or local practices for replacing cells.

- Avoid using an open flame or creating sparks, including those from static electricity, near the batteries.

3.9 Standby power system checks

Maintenance of the DMS standby power system is crucial to the prevention of switch downtime resulting from commercial power interruptions. Keep detailed records to ensure that proper maintenance of the standby power system is being performed. This section recommends several records and control logs for recording maintenance information on the standby power system. Other forms or systems that record the same information may be substituted.

Office control records and logs provide a means for tracking key maintenance information on the performance and reliability of standby power equipment.

The routine run frequency of the standby engine-alternators is based on local conditions. However, a minimum routine run of two hours under a normal loaded condition once per month, and a routine run of seven hours once per year, is recommended.

The frequency of a routine run in locations using mobile standby engine-alternators is based on local conditions. However, a routine run of once per year is recommended.

Each time a routine run is performed, verify that stationary engine-alternators start properly and mobile engine-alternators are dispatched and connected in a timely manner. Check the load on 3-phase alternators for proper load balance to determine if it is within the capacity of the alternator. Check the engine for proper fuel, lubricant, and coolant levels.

The forms in Figure 3–5 and Figures 3–7 through 3–12 are the suggested forms for recording the results of the routine engine-alternator runs.

3.10 Standby engine-alternator checks

Perform the following checks on the standby engine-alternator. Record any problems found in the maintenance action record (Figure 3–14).

- Check the location of the operating instructions to verify that they are within view of the controls.
- Check the operating instructions to verify that they provide simple, step-by-step instructions for operating the engine.
- Check the instructions for connecting the standby engine-alternator to verify that the instructions are clear and that the alternator connection can be made quickly.
- Check the engine run log (Figure 3–7) for a complete, continuing record of standby engine runs.
- Check the engine run log (Figure 3–7) to verify that the standby engine is being run at the prescribed minimum intervals.
- Check all standby engine-alternators to verify that they are operable and available for service.
- Check the operation of the ventilation system associated with the fresh air supply and exhaust gasses to verify that they operate as required.
- Check the standby engine for oil and coolant, for fuel leaks, and for loose or broken parts.
- Check the office records (Figure 3–12) to verify that a list of mobile standby engine-alternators is available.
- Check the emergency shut-down switch to verify that it is in a safe location.
- Check the office records to verify that the check for water in the fuel tank is being performed.
- Check the office records to determine if testing of the emergency shut-down features is being done on an annual basis.
- Check the office records (Figure 3–9) to verify that the electrolyte level and float voltage of the standby engine-alternator starting batteries is being made and recorded.
- Check the trickle charging equipment to verify that it is installed and functioning.
- Check the standby alternator to determine if, as recommended by NT, it is wired as a non-separately derived source with a non-switched neutral bonded to the engine frame, or if it is wired as a separately derived source with a switched neutral bonded to the engine frame.

3.11 Standby power system exercise

The standby power system exercise is a simulated failure of commercial ac power source to verify that all standby power equipment functions normally and continuity of service is maintained. The exercise is under control of local supervision and provides an opportunity for network maintenance and building personnel to:

- increase their familiarity with power plant capabilities and operation
- observe the interaction of the power plant subsystems under controlled conditions
- identify and correct unsatisfactory conditions
- test the coordination and allocation of mobile engine-alternators.

Perform the standby power system exercise under load a minimum of once a year, preferably following a recently completed power plant maintenance job. Several sample forms are provided for use in recording the results of the standby power system exercise. These are suggested forms. If forms that record the same information already exist, use the existing forms in place of the forms provided in this document. Otherwise, locally reproduce the forms provided in this document for use in performing the standby power system exercise.

3.11.1 Precautions

> **WARNING**
> **Damage to data facilities**
> Close liaison with computer communications personnel is strongly recommended if data facilities are, or could be, affected by the exercise.

Observe the following precautions before performing this exercise:

- Ensure all personnel participating in this exercise are familiar with power plant and battery room safety procedures.
- Ensure that sufficient personnel are available and trained to operate and observe switching equipment, standby engine-alternators, power plants, and expected alarm conditions, including alarms monitored remotely.
- Ensure that all personnel are familiar with the required tests and objectives.
- Verify that commercial ac power conditions will be stable. That is, no thunderstorms, freezing rain, high winds, or other hazardous conditions are forecasted.
- Ensure that equipment requiring uninterrupted power is identified and protected.

3.11.2 Preparations

Before starting this exercise, perform the following preparatory steps:

1 Perform the following precautionary checks. If any items are found to be unsatisfactory, do not proceed with this exercise until unsatisfactory items are corrected.

a. Check battery float voltages measured earlier for proper voltage levels.

b. Check the rectifiers and/or generators to determine if they are available for service.

c. Check the engine oil level in the standby engine (dip stick or oil indicator).

d. Check the standby engine fuel gauge to determine if sufficient fuel is available.

e. Check the standby engine for lube, fuel, and coolant leaks.

f. Check the standby engine block heater for proper operation.

g. Check the standby engine room environmental control equipment for proper operation.

h. Check the adequacy of the office local records and drawings.

2 Fill in the following forms:

- Standby power system exercise evaluation report (Figure 3–9):
  - — Location evaluated
  - — Date
  - — Level 1 supervisor
- Standby power system exercise control log (Figure 3–10):
  - — Location
  - — Size of standby engine used (in kW)
  - — Normal office load in amps; essential and building.
  - — Battery reserve capacity
- Stationary engine-alternator log (if a stationary engine-alternator is installed) (Figure 3–11):
  - — Date and time
  - — Ambient temperature
- Mobile engine-alternator log (if only mobile generators are available) (Figure 3–12):
  - — Office
  - — Date
- Battery load test record (if a battery load test is planned) (Figure 3–13):
  - — Location

- — Date
- — String #
- — Battery #

3 Verify the accuracy of dc voltmeters to be used in this procedure by comparison with a secondary standard meter.

4 Standby power system exercise evaluation report (Figure 3–9):

- — Measure the float voltages for each battery plant and record in row 1.
- — Measure the load currents in amps for each battery plant and record in row 2.
- — Record the normal and peak kilowatt loads on the commercial ac power source in row 3.

5 Verify that the standby engine-alternator has not been run within the last eight hours. Part of this exercise is to test the cold start capability of the standby engine.

3.11.3 Procedure

After completing the above preparatory steps, perform the standby power system exercise as follows:

1 Assign personnel to power plants, building equipment, switchgear, standby engine-alternators, and alarms.

Note: Steps 2 through 5 below should be performed as quickly as possible.

2 Remove the ac power from all rectifiers, one at a time. Record the time the ac is removed from each in row 4 of the standby power system exercise evaluation report (Figure 3–9) until all charging plants are on discharge.

Note: This reduces the load on the main ac switchgear, which prevents any unnecessary damage to the switches when they are operated during the simulated ac power failure.

3 Observe the bus voltage and record the voltage at which the batteries stabilize in row 5 of the standby power system exercise evaluation report (Figure 3–9).

4 Record the voltage at which the end cells, if provided, operate in row 6 of the standby power system exercise evaluation report (Figure 3–9).

5 Observe that the mechanical operation of all end cell switches, if provided, meets the requirements of their manufacturer.

6 Check the intercell connections for heating. Mark any connections which are excessively hot as in need of cleaning and/or tightening.

7 Record any office alarms raised in row 7 of the standby power system exercise evaluation report (Figure 3–9).

8 If using a stationary standby engine-alternator, have someone at the engine prepared to measure the engine cranking time and start the engine if is is a manual start engine.

Note: There should be no prior warm-up of the standby engines for this test.

9 Simulate an ac power failure by opening the commercial ac power circuit breaker. Record the time the ac power was removed in the standby power system exercise control log (Figure 3–10).

10 If a stationary standby engine-alternator is installed, and the engine is automatically started, monitor the length of time the engine cranks before starting and the time at which the engine starts and the alternator load transfers.

If the engine is manually started, operate the engine starter and note the length of time the engine cranks before starting, the time when the engine starts, and the time when the alternator load transfers.

a. Record the engine cranking time and start time in row 8 of the standby power system exercise evaluation report (Figure 3–9).

b. Record the engine transfer time in row 9 of the standby power system exercise evaluation report (Figure 3–9).

c. Observe that the transfer occurs properly for all equipment which should normally transfer under emergency operating conditions.

11 If mobile engine-alternators are to be used, do the following:

a. Call the dispatcher to get an emergency alternator dispatched to the office.

b. As soon as the alternator arrives, note the time of its arrival, connect the alternator as quickly as possible, and start the engine. Note the time the alternator was started.

c. On the mobile engine-alternator log (Figure 3–12), record the time the alternator arrived in the TIME EMG ENGINE DSPCH column, the size of the alternator in kW in the SIZE OF ENGINE DSPCH column, and the time the alternator was connected in the TIME EMG ENGINE CONND column.

12 Check the adequacy of dc lighting and note any deficiencies.

13 The batteries have been on discharge since the ac power was removed. This test may be continued as a battery load test as deemed necessary of desirable by the supervisor.

— If a battery load test is desired, enter YES in row 11 of the standby power system exercise evaluation report (Figure 3–9) to indicate a battery load test was performed, and continue with Step 14 below.

— If a battery load test is not desired, in the standby power system exercise evaluation report (Figure 3–9), record the voltage reached in row 10, enter “NO” in row 11, and go to Step 17 below.

14 Determine the appropriate duration of the battery load test.

Note: Depending on the discharge load on a power plant, the duration of a battery load test for the purpose of this exercise must not normally exceed normal time limits prescribed in Table 3–5 or the power plant low voltage limits. Any deviation beyond the limits indicated in the Table 3–5 must only be made by agreement with the appropriate engineering personnel.

Table 3–5
Recommended battery load test duration

OFFICE DISCHARGE LOAD (percent of an 8-hour discharge rate)	DURATION OF BATTERY LOAD TEST
90 %	90.0 min
100 %	60.0 min
120 %	47.5 min
140 %	37.5 min
160 %	32.5 min
180 %	27.5 min
200 %	22.5 min

15 Measure the terminal voltage of each battery and record the voltage in the battery load test record (Figure 3–13).

16 Record the duration of the test and the terminal voltage of each battery at the end of the test in the battery load test record (Figure 3–13).

17 Restore power to the rectifiers one at a time until all rectifiers are operating normally.

Note: This places the office ac load on the standby engine-alternators.

18 Observe the standby engine-alternator for evidence of an overload condition with all charging units connected.

19 Observe and check various features of the plant and overall operation. Record all deficiencies.

20 Continue operation of the office on the standby engines for the length of time planned.

21 Observe and record the alternator kilowatt load, voltage, and current by phases as a check of load balance and record in the appropriate engine-alternator log (Figure 3–11 or 3–12).

22 Determine the essential and building load on the standby engine-alternator and record in the standby power system exercise control log (Figure 3–10).

23 At the standby engine, record the following in the appropriate engine-alternator log (Figure 3–11 or 3–12):

- engine temperature
- oil pressure
- RPM

24 Return to commercial ac operation as follows:

- For automatic start engine-alternators:
  - Close the ac circuit breaker opened in Step 9 and record the time the ac power was restored in the standby power system exercise control log (Figure 3–10).
  - Observe and record the transfer time in row 13 of the standby power system exercise evaluation report (Figure 3–9).
  - Observe and record the time from transfer to engine stop in row 14 of the standby power system exercise evaluation report (Figure 3–9).
  - Restore the rectifiers to normal one at a time.
- For manual start engine-alternators:
  - Remove the input power to all rectifiers as described previously in Step 2.
  - Close the ac circuit breaker opened previously in Step 9 and record the time the ac power was restored in the standby power system exercise control log (Figure 3–10).
  - Stop the standby engines.
  - Restore the rectifiers one at a time to normal.

25 Observe and check various features of the plant and overall operation as necessary. Record any deficiencies found.

26 Note the time at which the test was completed and record in row 15 of the standby power system exercise evaluation report (Figure 3–9).

27 Recharge the batteries as required.

28 Review the information in all of the forms used. Summarize the results and deficiencies noted. Describe any corrective actions required.

3.12 Miscellaneous power plant checks

Perform the following miscellaneous checks on the power system. Record any problems found in the maintenance action record.

- Check the emergency lighting system to verify that there is adequate emergency lighting in critical areas.
- Check the office records to verify that a list of critical telephone numbers is available.

- Check with operating company management to verify that power-trained craftspersons are available.
- Check the battery room to verify that battery room safety equipment is available. Refer to Section 3.5 Power plant safety for a list of battery room safety equipment..
- Check the battery room tool storage area to verify that insulated tools are available.
- Check the tool room for an earth megger and high-voltage measuring devices.

3.13 Submitting the maintenance report

Upon completion of the DMS power system maintenance job, review all forms used and any notes taken. If any corrective action is required, submit the maintenance action record to the maintenance group for further analysis and action. File all of the forms used and any notes taken in the office records.

4 Grounding system maintenance

Accurate diagrams and appropriate tools are essential to the maintenance of the grounding system.

4.1 Grounding system diagrams

There should be an accurate schematic diagram of the grounding system, as well as floor plan diagrams showing the location of grounding system components at the DMS site. The schematic diagram should show:

- the various grounding bars
- the grounding leads to each grounding bar
- the magnitude and direction of the current on each grounding lead.

The floor plan should show the location of each DMS cabinet or frame and each ground bar in the grounding system. If such diagrams are not at the DMS site, contact the operating company engineering group to obtain these diagrams.

4.2 Tools required

Typical tools for performing maintenance on the DMS switch grounding system are as follows:

- flashlight
- stiff, non-metallic bristle brush
- wire brush
- voltmeter capable of measuring up to 100 V dc (or equivalent)
- clamp-on ammeter (or equivalent)
- torque wrench
- blank cable tags
- note pad for recording problems

4.3 Building principal ground (BPG) checks

The BPG is the main point within a building at which the ground reference potential is established. The BPG is directly referenced to earth by such means as water pipes and/or electrodes driven into the earth. See Table 1–1 for terms used by various operating companies to designate the BPG and other grounding bars.

DANGER
Risk of electrocution / risk of service outage
Connections to the BPG must never be broken. Disconnecting a grounding conductor from the BPG can cause electrocution and a service outage. If a connection must be disassembled, an appropriately-sized jumper must be installed from the cable end to the ground bar BEFORE the connection is disassembled.

Perform the following checks:

1 Locate the BPG and verify its correct location on the floor plan. If the floor plan is incorrect, make a note that the floor plan needs to be corrected.

2 Verify that all cables attached to the BPG are labeled. If any cables are unlabeled, do the following:

   a. Write ID REQ on a blank label and fasten it to the unlabeled cable.

   b. Make a note that unmarked cables on the BPG must be identified and properly labeled.

3 Verify the connections shown on the schematic diagram match the actual connection on the bar. If there are connections on the bar that are not shown on the schematic:

   a. Write NOT ON SCHEMATIC on a blank label and fasten it to the cable not shown on the schematic.

   b. Make a note that a possible illegal connection has been made to the BPG or the schematic needs correcting.

4 Using the clamp-on ammeter, measure the current magnitude and direction on each cable attached to the BPG. Compare the values with those on the schematic. If any current value does not match the value indicated on the schematic:

   a. Write CURRENT OUT OF SPEC on a blank label and fasten it to the cable where the incorrect current was read.

   b. Make a note that a possible grounding fault or violation has been made on the equipment attached to this cable, or that the schematic needs to be corrected.

5 Use the non-metallic brush to remove any accumulation of dust from the BPG, the connections, and bar-mounting insulators (if used). Dust and dirt attract moisture, which can promote corrosion and can affect the insulating properties of the insulators.

6 Inspect each connection for signs of corrosion. If any connection appears corroded, make a note that the corroded connections must be cleaned.

If any problems were noted, schedule corrective action as soon as possible. If necessary, contact your engineering group for assistance in identifying unmarked cables or in locating and clearing any grounding faults or violations found. Use the procedure in Section 4.16 to clean any connections that appear corroded.

After the corrective actions have been made, remove any note labels, such as, ID REQ, NOT ON SCHEMATIC, or CURRENT OUT OF SPEC, that may have been attached to the cables.

4.4 Ground resistance test

Measure the resistance between the BPG and earth, and verify that the resistance is as specified in NTP 297-1001-156. Use a suitable test method, such as the three electrode fall of potential method as described in the *James G. Biddle Earth Testing Manual 25T,* or any method approved by the local electric company.

4.5 Floor ground bar (FGB) checks

If the building is a multi-story building and the DMS SPG is a separate bar from the FGB, perform the following checks on the FGB. See Table 1–1 for terms used by various operating companies to designate these bars.

1 Check the floor plan of the floor where the FGB is located. Verify the location of the FGB is correct on the floor plan. If the location is incorrect, make a note that the floor plan must be updated.

2 Check each cable connected to the FGB for proper identification tags. If any cables connected to the FGB are not labeled, write “ID REQ” on a blank label and attach it to the unlabeled grounding cable.

3 Check each connection on the FGB against the grounding schematic. Verify that all connections to the FGB appear on the grounding schematic. If any connections to the FGB do not appear on the grounding schematic, write “NOT ON SCHEMATIC” on a blank label and attach it to each cable not appearing on the schematic.

4 Check each cable connection for tightness. Tighten any loose connections.

5 Using a non-metallic brush, brush off any accumulations of dirt or dust from the bar and any mounting insulators, if used. Excessive accumulations of dirt and dust can promote corrosion and can affect the insulating properties of insulators.

If any connections to the FGB are not on the grounding schematic, make a note that the grounding schematic must be updated. If any cables are unlabeled, make a note that cables marked at the FGB must be identified and properly labeled.

4.6 Power plant grounding checks

Perform the following checks:

- Verify that all power plant grounding cables are labeled. If any power plant grounding cables are not labeled, write “ID REQ” on a blank label and attach the label to the unlabeled grounding cable.
- Verify that all power plant grounding cables appear on the grounding schematic. If any power plant conductor does not appear on the schematic, write “NOT ON SCHEMATIC” on a blank label and attach it to the grounding cable not on the schematic.
- Check each grounding connection for corrosion, particularly those on and around the battery plant. If any connections appear corroded, make a note that the corroded connections must be cleaned.

If any cables were unlabeled, make a note that the marked grounding cables in the power plant must be identified. If any cables do not appear in the grounding schematic, make a note that the grounding schematic must be updated or a possible illegal grounding connection has been made. Use the procedure in Section 4.16 to clean any connections that appear corroded.

Do not forget to remove any ID REQ or NOT ON SCHEMATIC tags on the grounding cables after corrective action has been taken.

4.7 AC grounding checks

All general purpose ac distribution centers equipped with circuit breakers suitable for feeding lighting fixtures are supplied by the customer.

All ac equipment and its associated distribution must be installed in accordance with the NEC or CEC, and must comply with other applicable codes and regulations.

4.7.1 AC-free DMS switch

To maintain the integrity of the IBN, all ac-powered loads within the switch, as well as all convenience outlets incorporated into the DMS equipment are powered from internal inverters.

If for any reason external ac power distribution circuits are brought into the switch IBN, they shall be referenced to the DMS SPG in accordance with the applicable requirements of NTP 297–1001–156.

4.7.2 Other DMS switch versions

For DMS switch installations that do not feed all of their loads from internal inverters, external ac power suitable to the loads is required (and shall be supplied by the customer). Depending on the type of load, one or more of the following ac supplies can be used:

- commercial ac
  - ac panel dedicated to DMS, or
  - branch circuits (when very little ac power is needed)
- special ac
  - standby engine alternator
  - stand-alone inverter
  - isolation transformer
  - UPS

Locate the main ac service panel and any branch ac panels serving DMS switch equipment. Verify the fuses or circuit breakers on all ac circuits to the DMS switch are rated at 15 Amps. If any fuses or circuit breakers are greater than 15 Amps:

- For fuses, arrange to have improper fuses replaced with properly sized fuse. Take any precautions necessary for the removal of ac power from the affected equipment.
- For circuit breakers, arrange to have a certified electrician replace the improper circuit breakers with the properly sized breaker. Take any precautions necessary for the removal of ac power from the affected equipment.

At least yearly, arrange to have the ac surge protectors checked by the local utility company. Excessive surges may cause the protectors on one or more phases to fail.

4.8 DMS SPG checks

The DMS SPG serves as the single ground connection point of the DMS switch. In a small single-story building, the SPG can be the BPG; or, in a multi-story building, the SPG can be an FGB or a separate bar referenced to a FGB. A section of the BR bar on the power plant may also be used as the DMS SPG. See Table 1–1 for terms used by various operating companies to designate these bars.

Check your grounding schematic to determine the configuration of the DMS SPG in your building. If the DMS SPG is a bar separate from the FGB or BPG, perform the following checks:

1 Check the floor plan of the floor where the DMS SPG is located. Verify that the location of the SPG is correct on the floor plan. If the location is incorrect, make a note that the floor plan must be updated.

2 Check each cable connected to the DMS SPG for proper identification tags. If any cable connected to the SPG is not labeled, write “ID REQ” on a blank label and attach it to the unlabeled grounding cable.

3 Check each connection on the DMS SPG against the grounding schematic. Verify that all connections to the DMS SPG appear on the grounding schematic. If any connections to the SPG do not appear on the grounding schematic, write “NOT ON SCHEMATIC” on a blank label and attach it to each cable not appearing on the schematic.

4 Check each cable connection for tightness. Tighten any loose connections.

5 Using a non-metallic brush, brush off any accumulations of dirt or dust from the bar and any mounting insulators, if used. Excessive accumulations of dirt and dust can promote corrosion and can effect the insulating properties of insulators.

If any connections to the DMS SPG are unlabeled, make a note that the cables marked at the SPG must be identified. If any connections on the SPG are not on the grounding schematic, make a note that possible illegal connections have been made to the DMS SPG or that the grounding schematic must be updated.

4.9 Framework bonding equalizer (FBE) checks

In an ISG office, an FBE bar is used to bond DMS cabinets and frames to the DMS SPG. Perform the following checks on the FBE:

1 Check the floor plan diagram for the location of the FBE. Verify the location of the FGE on the floor plan is correct. If the location is incorrect, make a note that the floor plan must be updated.

2 Verify that each connection on the FBE is properly labeled. The label should specify the lineup and frame from which the grounding cable originates. If any connection is not labeled, write “ID REQ” on a blank label and attach it to the unlabeled cable.

3 Verify that each connection on the FBE appears on the grounding system schematic. If any connection on the FBE does not appear on the grounding schematic, write “NOT ON SCHEMATIC” on a blank label and attach it to the cable not appearing on the schematic.

4 Verify that only the following bonding connections are made to the FBE:

   a. DMS lineup with a DPCC or PDC: the framework bonding bar (FBB) of the PDC in that lineup must be bonded to the FBE.

b. DMS lineup without a DPCC or PDC: the FBB of the cabinet or frame closest to the FGE in that lineup must be bonded to the FBE.

c. Spare circuit card storage cabinet: IF the storage cabinet is more than 2 m (7 ft) away from any metallic object that is not referenced to the DMS SPG and the storage cabinet has no connections to a non-DMS cabinet, the storage cabinet must be referenced to the FBE.

If any other cable was bonded to the FBE, write “ILLEGAL CONNECTION” on a blank label and attach it to the cable. Make a note that an illegal connection must be removed from the FBE.

5 Check each connection to the FBE for tightness. Tighten any loose connections.

If the need for any corrective action was noted, do not forget to remove any ID REQ, NOT ON SCHEMATIC, or ILLEGAL CONNECTION tags from the grounding cables after the corrective action has been performed.

4.10 Framework ground bus checks

In non-ISG offices, a framework ground bus is used to bond DMS frames to the DMS SPG. If this is a non-ISG office, perform the following checks on the framework ground bus:

1 Check the floor plan diagram for the location of the framework ground bus. Verify that the location of the framework ground bus on the floor plan is correct. If the location is incorrect, make a not that the floor plan must be updated.

2 Verify that each connection on the framework ground bus is properly labeled. The label should specify the lineup and frame from which the grounding cable originates. If any connections are not labeled, write “ID REQ” on a blank label and attach it to the unlabeled cables.

3 Verify that each connection on the framework ground bus appears on the grounding system schematic. If any cable bonded to the framework ground bus does not appear on the grounding schematic, write “NOT ON SCHEMATIC” on a blank label and attach it to the cable.

4 Verify that only the following connections are made to the framework ground bus:

a. FBB of first PDC

b. FBB of last PDC

c. Spare circuit card storage cabinet: IF the storage cabinet is more than 2 m (7 ft) away from any metallic object that is not referenced to the DMS SPG and the storage cabinet has no connection to a non-DMS cabinet, the storage cabinet must be referenced to the framework ground bus.

If any other cable was bonded to the framework ground bus, write “ILLEGAL CONNECTION” on a blank label and attach it to the cable. Make a note that an illegal connection must be removed from the framework ground bus.

5 Check each connection to the framework ground bus for tightness. Tighten any loose connections.

If the need for any corrective action was noted, do not forget to remove any ID REQ, NOT ON SCHEMATIC, or ILLEGAL CONNECTION tags from the grounding cables after the corrective action has been performed.

4.11 Logic return equalizer (LRE) checks

In an ISG office, the logic return is isolated from framework ground and battery return. An LRE bar is used to bond the logic return of DMS cabinets and frames to the DMS SPG. If this is an ISG office, make the following checks on the LRE:

1. Verify that the location of the LRE on the floor plan diagram is correct. If the location is incorrect, make a note that the floor plan must be updated.
2. Verify that all cables connected to the LRE are labeled. Labels should indicate the LRB where the cable originated. If any cables are not labeled, write“ID REQ” on a blank label and attach it to the unlabeled cable.
3. Verify that all connections to the LRE appear on the grounding system schematic. If any connection does not appear on the schematic, write “NOT ON SCHEMATIC” on a blank label and attach it to the cable not shown on the schematic. Make a note that the grounding schematic must be updated.
4. Verify that no connections, other than LRB connections from each DMS lineup, are made to the LRE. If any other connection was made to the LRE, write “ILLEGAL CONNECTION” on a blank label and attach it to the illegally connected cable. Make a note that an illegal connection must be removed from the LRE.
5. Check each connection for tightness. Tighten any loose connections.

If the need for any corrective action was noted, remove any ID REQ, NOT ON SCHEMATIC, or ILLEGAL CONNECTION tags from the grounding cables after corrective action has been taken.

4.12 Logic return bar (LRB) checks

In an ISG office, LRBs are used to bond the logic return of DMS cabinets and frames to the LRE. If this is an ISG office, make the following checks on the LRBs:

1. Verify that the location of an LRB is correct on the floor plan diagram. If the location on the floor plan is incorrect, make a note that the floor plan must be updated.
2. Verify all cables attached to an LRB are labeled. Labels should indicate the DMS cabinet or frame where the cable originated. If any cable on the LRB is not labeled, write “ID REQ” on a blank label and attach it to the unlabeled cable.
3. Verify that all connections to an LRB appear on the grounding system schematic. If any cable connection does not appear on the schematic, write “NOT ON SCHEMATIC” on a blank label and attach it to the cable. Make a note that the schematic must be updated to include this connection.
4. Verify that only logic return connections are made to an LRB. If any other connection is made to an LRB, write “ILLEGAL CONNECTION” on a blank label and attach it to the illegally connected cable. Make a note that the illegal connections must be removed.
5. Check each LRB connection for tightness and tighten any loose connections.

If the need for any corrective action was noted, do not forget to remove any ID REQ, NOT ON SCHEMATIC, or ILLEGAL CONNECTION tags from the grounding cables after the corrective action is performed.

4.13 Bonding within DMS cabinets/frames

In each cabinet/frame, check all bonding to the framework bonding bars (FBBs) and vertical logic return bars for tightness. Also, check FBB mounting connections to the framework. Tighten any loose connections.

4.14 Cable entrance ground bar (CEGB) checks

If a CEGB is used, perform the following checks:

1. Using the floor plan, locate the CEGB. Verify that the location shown in the floor plan is correct. If the location is incorrect, make a note that the floor plan needs to be corrected.
2. Using the schematic diagram, verify connections shown on the schematic match the actual connections on the CEGB. If any connections on the CEGB are not on the schematic, do the following:
   a. Write “NOT ON SCHEMATIC” on a blank label and attach it to the cable that is not on the schematic.
   b. Make a note that a possible grounding violation has been made or that the schematic needs to be updated.

3 Using the non-metallic brush, brush off any accumulations of dust on the bar and connectors.

4 Inspect each CEGB connection for signs of corrosion. If any connections are corroded, make a note that the corroded connections must be cleaned.

5 Using a torque wrench, verify that each connection is tight.

If any connections to the CEGB were not shown on the grounding system schematic, contact the engineering department. If necessary, remove the connection from the CEGB or to add the connection to the schematic. Use the procedure described in Section 4.16 to clean any connections that appear corroded.

4.15 Main distribution frame/protector frame checks

Perform the following checks:

1 Verify that all MDF/protector frame grounding cables are labeled. If any are not labeled, do the following:

   a. Write ID REQ on a blank label and attach it to the unlabeled cable.

   b. Make a note that a cable on the MDF/protector frame must be identified.

2 Verify that all MDF/protector frame grounding connections are shown on the schematic. If any connections are not shown, do the following:

   a. Write NOT ON SCHEMATIC on blank label and attach it to the cables that are not shown.

   b. Make a note that a possible grounding violation has been made or that the schematic needs updating.

3 Using the non-metallic brush, brush off any accumulations of dust from the grounding bars and connections.

4 Inspect each grounding connection for corrosion. If any connections are corroded, make a note that the corroded connection(s) must be cleaned.

5 Using a torque wrench, verify that all MDF/protector frame grounding connections are tight.

If any MDF/protector frame grounding cables were unlabeled or were not shown on the grounding schematic, contact the engineering group, if necessary, to have the unlabeled cables properly labeled or to have any connections not shown on the schematic removed from the MDF/protector frame or added to the schematic. Use the procedure in Section 4.16 to clean any connections that appear corroded. Do not forget to remove any ID REQ or NOT ON SCHEMATIC tags after corrective action has been performed.

4.16 Cleaning corroded grounding connections

DANGER
Risk of electrocution / risk of service outage
Removing a grounding conductor from a ground bar can cause electrocution and a service power outage. If a cable connection must be removed, install an appropriately-sized jumper before the end of the cable to the ground bar BEFORE the connection is broken.

Use the following procedure for cleaning corroded grounding bar connections.

1 The connection hardware will have to be replaced. Note the connection hardware used and the proper orientation of each piece used. Obtain new hardware.
2 Obtain a jumper of the same size as the cable to be disconnected.
3 Attach one end of the jumper to the ground bar.
4 Attach the other end of the jumper to the cable end.
5 Remove the bolts to the connection and carefully separate the cable connector from the ground bar.
6 Discard the old mounting hardware.
7 Using a wire brush, remove all traces of corrosion and oxides from both the mating surface on the ground bar, and the cable connector.
8 Apply a light coating of NO–OX–ID “A” grease to the mating surface of the grounding bar and the cable connection.
9 Re-attach the cable connector to the ground bar using the new mounting hardware. Ensure the correct mounting hardware is used and that each piece is properly oriented.
10 Using the torque wrench, tighten the mounting bolts to the proper torque.
11 Remove the jumper connection from the cable connector.
12 Remove the jumper connection from the ground bar.
13 Repeat this procedure for any other connections showing signs of corrosion.
14 Using the torque wrench, verify that all connections are tight.

4.17 Grounding audit

The grounding audit is a series of checks performed on the DMS grounding system for the purpose of detecting and correcting violations of DMS switch grounding practices. The grounding audit is performed on new installations and on existing installations when new equipment is added or when frequent grounding-related problems are experienced. Grounding audit procedures are described in NTP 297-1001-158.

DMS-100 Family

Digital Switching Systems

Power and Grounding Routine Maintenance Manual

Product Documentation—Dept 3423
Northern Telecom
P.O. Box 13010
RTP, NC 27709–3010
1-877-662-5669, Option 4 + 1

Information is subject to change without notice. Northern Telecom reserves the right to make changes in design or components as progress in engineering and manufacturing may warrant.This equipment has been tested and found to comply with the limits for a Class A digital device pursuant to Part 15 of the FCC Rules, and the radio interference regulations of the Canadian Department of Communications. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at the user's own expense

Allowing this equipment to be operated in such a manner as to not provide for proper answer supervision is a violation of Part 68 of FCC Rules, Docket No. 89-114, 55FR46066

This equipment is capable of providing users with access to interstate providers of operator services through the use of equal access codes. Modifications by aggregators to alter these capabilities is a violation of the Telephone Operator Consumer Service Improvement Act of 1990 and Part 68 of the FCC Rules

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