UNITED STATES DEPARTMENT OF AGRICULTURE
Rural Electrification Administration

BULLETIN 1751E-302

SUBJECT: **Power Requirements for Digital Central Office Equipment**

To: All Telephone Borrowers
REA Telephone Staff

EFFECTIVE DATE: Date of Approval

EXPIRATION DATE: Three years from effective date

OFFICE OF PRIMARY INTEREST: Central Office Equipment Branch, Telecommunications Standards Division

PREVIOUS INSTRUCTIONS: This bulletin replaces REA Telecommunications Engineering & Construction Manual (TE&CM) Section 302, Power Requirements for Community Central Office Equipment, Issue No. 6, dated April 1989.

FILING INSTRUCTIONS: Discard REA Telecommunications Engineering & Constructions Manual (TE&CM) 302, Power Requirements for Digital Central Office Equipment, Issue 6, dated April 1989, and replace it with this bulletin. File with 7 CFR 1751 and on REANET.

PURPOSE: This bulletin provides REA borrowers and other interested parties with information concerning power requirements for digital central office equipment.

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10/15/93
Date

TABLE OF CONTENTS

INDEX:
Power Requirements For Digital Central Office Equipment

ABBREVIATIONS

AC	Alternating Current
AH	Ampere Hour
AM	Administrative Module
AMAF	Automated Message Accounting Frame
BHA	Busy Hour Attempts
BMC	Billing Media Converter
BTU	British Thermal Unit
CC	Common Control
CCS	Hundred Call Seconds
CM	Communication Module
CMF	Control and Maintenance Frame
COE	Central Office Equipment
CPU	Central Processing Unit
CUA	Circuit Unit Assembly
DAT	Digital Analog Trunk
DC	Direct Current
dc-ac	direct current - alternating current
dc-dc	direct current - direct current
DCI	Digital Carrier Interface
DCM	Digital Carrier Module
DCO-E	Digital Central Office Exchange
DCS-SE	Digital Central Office Small Exchange
DCTU	Digital Carrier Trunk Unit
DLTU	Digital Line & Trunk Unit
DTC	Digital Trunk Controller
DTMF	Dual - Tone Mutlifunction
GDSU	Global Digital Service Unit
GPIO	General Purpose Input Output
LCE	Line Concentrating Equipment
LCE	Line Concentrator Equipment
LGC	Line Group Controller
LLS	Local Line Switch
LTF	Line Trunk Frame
LU	Line Unit
MDX	Modular Digital Exchange
MMSU	Modular Metallic Service Unit
MSU	Modular Shelf Unit
MTM	Maintenance Trunk Module
OPM	Outside Plant Module
OPSM	Outside Plant Subscriber Module
P.E.	Peripheral Equipment
PCCM	Power Cooling Control Module
PDC	Power Distribution Center
PWBA	Printed Wire Board Assembly
RLCM	Remote Line Concentrator Module
RLG	Remote Line Group
RSLE	Remote Line Subscriber Equipment
RSLM	Remote Subscriber Line Module
SCM	Subscriber Carrier Module
SLC	Subscriber Loop Carrier
T&M	Trunk and Maintenance
TM	Trunk Module
TMF	Toll Multifunction
TU	Trunk Unit
v	volts

1. GENERAL

1.1 This bulletin is intended to provide REA borrowers, consulting engineers, contractors and other interested parties with technical information for use in the design and construction of REA borrowers' telephone systems. It discusses, in particular, the methods used in calculating the power requirements for central offices. It provides means to calculate the required capacities of the storage batteries and charging equipment for particular applications.

1.2 This bulletin replaces REA TE&CM 302, Power Requirements for Digital Central Office Equipment, Issue No. 6, dated April 1989. This bulletin provides power calculation methods for various digital, stored program controlled central office equipment.

1.3 General specifications governing storage battery and charging equipment for proposed Central Office Equipment (COE) are covered in Items 12.1 and 12.2, Part III, of Bulletin 1753E-001 (Form 522), "REA General Specification for Digital, Stored Program Controlled Central Office Equipment." Based on these general specifications, determination of the required capacities of battery and charger is made by the manufacturer.

2. BASIS FOR CALCULATIONS

2.1 Charging equipment furnished with a central office should have sufficient capacity to supply the dc power necessary for the satisfactory operation of the office during the busy hour. This includes the dc requirements for carrier, loop extenders, voice frequency repeaters, and dc-dc converters or dc-ac inverters to operate input/output devices.

2.1.1 Determination of the requirements for emergency generating and charging equipment is covered in Bulletin 1751E-320, "Emergency Generating and Charging Equipment." A suggested method of charger size computation is provided in Figure 8.

2.2 Charging equipment for digital central offices should be provided on one of the following bases:

(a) Two chargers either of which is capable of carrying the full office load; or

(b) Three chargers each of which is capable of carrying half the office load.

Arrangement (a) may be used in any central office power system. Arrangement (b) may offer potential cost savings when applied to power requirements in relatively large digital, stored program controlled offices.

2.3 Storage Battery

2.3.1 The storage battery furnished with a central office should have sufficient capacity to supply the dc power necessary to sustain satisfactory operation of the exchange for the period specified.

Specific REA minimum requirements are in 7 CFR 1755.522, which is also contained in Part III of REA Bulletin 1753E-001 (Form 522). Appropriate allowances should be included for any equipment which is normally ac operated but arranged for dc operation in case of an ac failure. See paragraph 1.3 of this bulletin for location of specific requirements in central office equipment specifications.

2.3.2 The minimum usable voltage to be delivered to the central office equipment during battery discharge should be determined using COE manufacturer's design criteria. When power flows from the battery through the power board to the equipment, a voltage drop (IR loss) is experienced as a result of the resistance of the current carrying conductors. In many cases equipment design is based on 44 volts being available at the power entry to the bay. Performance of the digital COE at voltages less than 44 volts becomes unpredictable. For effective design, voltage drop from the source to the equipment bay is considered by allocation as follows:

Battery to Power Board	0.5
Power Board to Equipment Bay	0.5
Minimum Equipment Voltage	44.0
Total	45V dc - 45.0 Vdc

In the case of a 24-cell battery (45/24) = 1.88 volts per cell becomes the minimum operating voltage.

2.3.3 The computation of battery size to meet the site power requirement is described in Figure 7 - Estimating Telephone Battery Sizes. This method permits computation with differing numbers of hours of reserve and numbers of cells in the battery string. The computation is applicable to lead-acid batteries, lead antimony, or lead-calcium batteries (see manufacturer's data for capacity, dimensions, etc.).

2.3.4 REA recommends that the battery provided should have the capacity to maintain the central office load for a period of 8 hours. Systems that are equipped with emergency generators are allowed to reduce the 8 hours to a 3-hour reserve time.

2.3.5 Determination of battery capacity to be supplied should be based on power outages experienced at the site and on the evaluation of the future performance of the ac power system. Another consideration is the size of the dc load to be supplied. Small electromechanical switching systems have a limited amount of fixed power consuming devices, while a large part of system devices only require power when in use. As a result battery capacity determinations were made assuming busy hour switching activity. The telecommunications industry considers 8 busy hour battery capacity appropriate for most small installations. The expectation of 8 consecutive busy hours of usage following a power interruption was negligible, resulting in battery power being usable for longer than the 8-hour period. Power consumption in digital switching equipment is almost constant, whether or not calls are being processed. In addition, the total power consumed by digital switches is greater than the electromechanical systems. The concept of "busy hour drain" has lost its impact in digital offices where the operating drain represents the constant load. The solution most often used is to provide an emergency generator to supply power on a long-term basis and to install a battery with 3 hours capacity.

3. CALCULATIONS

3.1 The following sample calculations describe the suggested procedure to determine the power requirements for digital, stored program controlled central office equipment. Sample calculations are included for the following switching equipment types:

Manufacturer	System Designation
Figure 1 - Northern Telecom	DMS-100, DMS-10
Figure 2 - Siemens Stromberg-Carlson	DCO
Figure 3 - Redcom	MDX
Figure 4 - AT&T	5 ESS
Figure 5 - Mitel	GX5000

3.2 Figure 6 lists various power requirements for loop extenders, voice frequency repeaters, carrier equipment and other equipment.

3.3 Figure 7 illustrates the method used in determining the capacity of a storage battery required for a particular application. This figure also illustrates, in Example 2, a method for calculating the ampere-hour reserve of existing batteries when the current requirement of the central office equipment is changed as a result of equipment additions or higher than anticipated calling rates, etc.

3.4 Figure 8 illustrates the suggested method used in determining charger capacity required for a particular application. If 110 percent of the rated output of the charger is equal to or greater than the calculated charger dc current requirement, the charger is considered as satisfactorily meeting the specification requirements. Three suggested solutions in terms of the number of chargers and their capacity are included.

3.5 In some cases specialized equipment requires power at a voltage different from the -48V dc central office battery. Dc-dc converters can be supplied at ±24V dc, ±48V dc, ±130V dc and other values. These other voltages are used to supply radio and carrier equipment operated at -24 volts, coin collect circuits at ±130 volts and other equipment. The power required by the dc-dc converters has to be included in the total load to be carried by the central office dc power system.

3.6 It should be kept in mind that the calculation methods shown in this section are to provide estimates only. Engineering judgment has to be used for each individual application. It is, therefore, recommended that the manufacturer of the system be consulted for specific applications.

Figure 1 NORTHERN TELECOM DMS-100

DC DRAIN

1.	Basic (CPU) CC Frame E/W 4 Memory Shelves I/O Frame E/W 2 Disk + 1 Mag Tape	78.5
2.	PDC Bays _______ x 6.5 Amps	_____
3.	LAMA or CAMA (10 Amps)	_____
4.	Combined Network Frame _______ x 24 Amps	_____
5.	Double Shelf Network _______ x 14 Amps	_____
6.	DTC _______ x 8.5 Amps	_____
7.	MTM _______ x 3.3 Amps	_____
8.	TM _______ x 2.2 Amps	_____
9.	LGC _______ x 8.5 Amps	_____
10.	Line Circuits LCE _______ x 8.2 + 4W (Note 1)	_____
	Subtotal	_____
	Customer Drain _______	_____
	DMS Current Total _______	_____

Note 1: W = 2 way CCS per line in unit drain formula

Figure 1.1 NORTHERN TELECOM DMS-100

E X A M P L E
1000 Lines, 50 Digital Trunks, 50 Analog Trunks, 3.2 CCS/Line

DC DRAIN

1. Basic (CPU) CC Frame E/W 4 Memory Shelves I/O Frame E/W 2 disk + 1 Mag Tape Drive	78.5
2. PDC Bays 1 x 6.5 Amps	6.5
3. LAMA or CAMA, 10 Amps	____
4. Combined Network Frame 1 x 24 Amps	24.0
5. Double Shelf Network ____ x 14 Amps	____
6. DTC 1 x 8.5 Amps	8.5
7. MTM 4 x 3.3 Amps	13.2
8. TM 1 x 2.2 Amps	2.2
9. LGC 1 x 8.5 Amps	8.5
10. Line Circuits LCE 1 x 8.2 + 4W (Note 1) (Sample - 1 x 8.2 + 4 x 3.2 - 21)	21.0
Subtotal	162.4
Customer Drain 20	20.0
DMS Current Total	182.4

NOTE 1: W - 2 way CCS per line in unit drain formula

Figure 1.2 NORTHERN TELECOM DMS-100

HEAT DISSIPATION

Type of Frame	Quantity	Heat Dissipation Per Frame (Watts/Hr)	Total Heat Dissipation
Central Control Complex	______	1720	______
Input/Output Frame	______	850	______
Miscellaneous Equipment	______	220	______
Network Combined	______	1000	______
Digital Trunk Equipment	______	1120	______
Trunk Module Equipment Frame	______	480	______
Line Concentrating Equipment	______	1050	______
Line Group Equipment	______	980	______
Power Distribution Center	______	200	______
		TOTAL WATTS/HOUR	______

Figure 1.3 NORTHERN TELECOM DMS-100

EXAMPLE
1400 Lines, 50 Digital Trunks, 50 Analog Trunks, 3.2 CCS/L

HEAT DISSIPATION

Type of Frame	Quantity	Heat Dissipation Per Frame (Watts/Hr)	Total Heat Dissipation
Central Control Complex	1	1720	1720
Input/Output Frame	1	850	850
Miscellaneous Equipment	1	220	220
Network Combined	1	1000	1000
Digital Trunk Equipment	1	1120	1120
Trunk Module Equipment Frame	2	480	960
Line Concentrating Equipment	1	1050	1050
Line Group Equipment	1	980	980
Power Distribution Center	1	200	200
		TOTAL WATTS/HOUR	**8100**

Figure 1.4 NORTHERN TELECOM STANDARD DMS-10 400 SERIES

DC DRAIN

Basic System				25.0 Amps
DCM Shelves	______	x 4.0	=	______ Amps
DCI Shelf	______	x 3.0	=	______ Amps
SCM-10S	______	x 10.0	=	______ Amps
P.E. Shelf	______	x 0.75	=	______ Amps
LCE Lines	______	x 0.015	=	______ Amps
BMC	______	x 5.0	=	______ Amps
D.C./A.C. Inverter (0.5 KW)	______	x 15	=	______ Amps
		Total	=	______ Amps

Heat Dissipation

D.C. Drain

Northern Telecom DMS-10 400 Generic (3 Bay)

Basic System				30.0 Amps
P.E. Shelf	______	x 0.75	=	______ Amps
DCM Shelf	______	x 4.0	=	______ Amps
LCE Lines	______	x 0.015	=	______ Amps
		Total	=	______ Amps

Heat Dissipation

D.C. Drain	______	x 52	______ Watts

Figure 1.5 NORTHERN TELECOM STANDARD DMS-10 400 SERIES

Example #1

5000 Lines, 576 Trunks, 1 RLCM, 1 SLC-96, 1 RSLE, 1 RSLM
@ 3.2 CCS/line

DC Drain

Basic System					25.0	Amps
DCM Shelves	4	x	4.0	=	16.0	Amps
DCI Shelf	1	x	3.0	=	3.0	Amps
SCM-10S	1	x	10.0	=	10.0	Amps
P.E. Shelf	2	x	0.75	=	1.5	Amps
LCE Lines	5000	x	0.015	=	75.0	Amps
BMC	2	x	5.0	=	10.0	Amps
D.C./A.C. Inverter (0.5 KW)	1	x	15.0	=	15.0	Amps
			Total	=	155.5	Amps

Heat Dissipation

DC Drain	155.5	x	52	=	8086	Watts

Example #2

Northern Telecom DMS-10 400 Generic (3 Bay)

1280 Lines, 144 Trunks, @ 3.2 CCS

Basic System					30.0	Amps
P.E. Shelf	2	x	0.75	=	1.5	Amps
DCM Shelf	1	x	4.0	=	4.0	Amps
LCE Lines	1280	x	0.015	=	19.2	Amps
			Total	=	54.7	Amps

Heat Dissipation

D.C. Drain	54.7	x	52	=	2844	Watts

Figure 1.6 NORTHERN TELECOM STANDARD DMS-10 400 SERIES
(Page 1 of 2)

1 - Standard 400 Series	AMPS
Basic System Current Drain	25.0
Network Module (Max. = 2 Modules)	12.0
DCM Shelf	4.0
DCI Shelf	3.0
SCM-10 (DMS-1) Shelf	4.0
SCM-10S (SLC-96) Module	10.0
Mag Tape Bay	7.8
BMC (each)	5.0
DC/AC Inverter 0.5 KW	15.0
DC/AC Inverter 1.0 KW	26.0
P.E. Lines	0.020
P.E. Shelf (with service circuits)	0.75
LCM Lines (per line)	0.015

2 - DMS-10 400 Series (3 bay)	AMPS
Basic System Current Drain (includes combination CPU/Network shelf and GPIO shelf)	30.0

3 - DMS-10 400 series (2 bay)	AMPS
CONTROL AND TRUNK BAY	
CPU/Network Shelf (5.8 amps ea. two required)	11.6
GPIO Shelf	4.8
T & M Shelf	2.9
PCCM Shelf	1.5
DAT Shelf	2.9
LINE AND TRUNK BAY	
Two Shelf LCM (E/W 640 Lines)	9.6
Bay Supervisory Panel	0.2
DAT Shelf each (max. = 2 shelves)	2.9

4 - DMS-10 400 Series (1 bay)	AMPS
CPU/Network Shelf (5.8 amps ea. two required)	11.6
T & M Shelf	2.9
PCCM Shelf	1.5
DAT Shelf	2.9
FSP (Frame Supervisory Panel) and LCM Shelf (E/W 256 lines)	4.8

Figure 1.6 NORTHERN TELECOM STANDARD DMS-10 400 SERIES
(Page 2 of 2)

5 - OPM	AMPS
One Cabinet	15.0
Line Current	0.015/L
6 - OPSM	AMPS
One Cabinet	9.0
Line Current	0.015/L
7 - RSLM	AMPS
RSLM Bay	6.0
Line Current	0.015/L
8 - RSLE	AMPS
RSLE Bay (up to 512 lines)	10.5
RSLE Bay (from 512 to 1024 lines)	21.0
Line Current	0.015/L
9 - RLCM	AMPS
RLCM Bay	10.0
LCE Bay	0.015/L

Figure 2 SIEMENS STROMBERG - CARLSON DCO-E/DCO-SE
(Page 1 of 3)

DC DRAIN

1. CONTROL & MAINTENACE FRAME (CMF)

			WATTS
DCO-E CMF (ONE PER DCO-E)	1	X 2400	= ____
DCO-SE CMF (ONE PER DCO-SE)	1	X 2000	= ____

2. LOCAL LINE SWITCH FRAME (LLS) (DCO-E & DCO-SE)

Quantity of Lines ____ x ____CCS/L	X	0.069 (LOAD)	= ____
Quantity of Lines	____ X	0.158 (IDLE)	= ____
Quantity Of Line CUAs	____ X	30.0	= ____
Quantity of RLG Host CUAs	____ X	31.0	= ____
Quantity of SLC Host CUAs	____ X	158.0	= ____
Quantity of LLS Frames	____ X	306.0	= ____
TOTAL LLS FRAME POWER REQUIREMENTS			= ____

3. LINE/TRUNK FRAME POWER (LTF) (DCO-E ONLY)

			WATTS
Quantity of DTMF Receiver PWBAs	____	X 19.3	= ____
Quantity of DTMF Sender PWBAs	____	X 5.0	= ____
Quantity of TMF Receiver PWBAs	____	X 8.5	= ____
Quantity of TMF Sender PWBAs	____	X 3.9	= ____
Quantity of Busy Verification PWBAs	____	X 2.3	= ____
Quantity of Analog Trunk PWBAs	____	X 8.2	= ____
Quantity of LTF CUAs	____	X 19.3	= ____
TOTAL LTF POWER REQUIREMENTS			= ____

4. DIGITAL TRUNK FRAME POWER (DTF) (DCO-E ONLY)

			WATTS
Quantity of T1 Interface PWBAs	____	X 11.2	= ____
Quantity of Message Assemblers	____	X 57.3	= ____
Quantity of DTF CUAs		67.4	= ____
TOTAL DTF POWER (WATTS)			= ____

5. POWER RINGING & TEST FRAME POWER (PRTF) (DCO-E ONLY)

			WATTS
Power Ringing & Test Frame	1	X 92.0	= 92.0
TOTAL PRTF POWER REQUIREMENTS			= 92.0

Figure 2 SIEMENS STROMBERG-CARLSON DCO-E/DCO-SE
(Page 2 of 3)

DC DRAIN

6. DATA COLLECTION FRAME POWER (AMAF)/(DCF) (DCO-E & DCO-SE)

			WATTS
AMA Frame (E/W Tape Drives)	_____	x 495.0	=_____
CODC Data Collection Frame	_____	X 523.0	=_____
TOTAL AMAF/DCF POWER REQUIREMENTS			=_____

7. COMMON EQUIPMENT FRAME POWER (CEF) (DCO-E) & DCO-SE)

	WATTS
Variable (Dependent on OEM Equipment Installed)	
TOTAL CEF POWER REQUIREMENTS	=_____

8. UNIVERSAL POWER FRAME (DCO-SE ONLY)

			WATTS
Universal Power Frame (UPF)	1	X 92.0	= 92.0
Expanded Ringing CUA	_____	X 70.0	=_____
*Universal Service CUA	_____	X 155.0	=_____
*Universal Trunk/Service CUA	_____	X 155.0	=_____
*Universal Trunk CUA	_____	X 132.0	=_____
*Customber Trunk Group CUA	_____	X 107.0	=_____
Quantity of DTMF Receiver PWBAs	_____	X 19.3	=_____
Quantity of DTMF Sender PWBAs	_____	X 5.0	=_____
Quantity of TMF Receiver PWBAs	_____	X 8.5	=_____
Quantity of TMF Sender PWBAs	_____	X 3.9	=_____
Quantity of Busy/Verification PWBAs	_____	X 2.3	=_____
Quantity of Analog Trunk PWBAs	_____	X 8.2	=_____
TOTAL UPF POWER REQUIREMENTS			=_____

9. REMOTE LINE SWITCH POWER (RLS)

			WATTS
RLS Frame (1080 Lines Maximum)	1	X 906.0	=906.0
Quantity of Lines _____ X _____	CCS/L	X 0.069 (LOAD)	=_____
Quantity of Lines	_____	X 0.158 (IDLE)	=_____
Quantity of Line CUAs	_____	X 30.0	=_____
Quantity of RLG CUAs	_____	X 31.0	=_____
Quantity of SLC CUAs	_____	X 158.0	=_____
TOTAL RLS FRAME POWER REQUIREMENTS			=_____

*ONLY 3 CUAs TOTAL CAN BE EQUIPPED

Figure 2 STROMBERG-CARLSON DCO-E/DCO-SE
(Page 3 of 3)

DC DRAIN

10. REMOTE LINE SWITCH - 450 POWER (DC)

	WATTS
Basic DC Power (Maximum)	= 1200
Maximum Allowed Customer Power	= 250
RLS-450 DC POWER TOTAL WATTS (Maximum)	= 1450
RLS-450 RATED AC POWER INPUT (Typical) (Based on cold weather heating plus maximum short term load.)	= 6000

SYSTEM DC POWER SUMMARY

11. DCO-E SYSTEM POWER

	WATTS
Total Control & Maintenance Frame Power	= 2400
Total Local Line Switch Power	= ____
Total Line/Trunk Frame Power	= ____
Total Digital Trunk Frame Power	= ____
Total Power Ringing & Test Frame Power	= 92.0
Total AMA/Data Collection Frame Power	= ____
Total Common Equipment Frame Power	= ____
TOTAL DCO-E SYSTEM DC POWER REQUIREMENTS	= ____ AMPS
TOTAL DCO-E DC BUSY HOUR LOAD (Total DC Power divided by 52.1 Volts)	= ____

12. DCO-SE SYSTEM POWER

	WATTS
Total Control & Maintenance Frame Power	= 2000
Total Local Line Switch Frame Power	= ____
Total AMA/Data Collection Frame Power	= ____
Total Universal Power Frame Power	= ____
Total Common Equipment Frame Power	= ____
TOTAL DCO-SE SYSTEM DC POWER REQUIREMENTS	= ____
TOTAL DCO-SE DC BUSY HOUR LOAD (Total DC Power divided by 52.1 Volts)	= ____ AMPS

Figure 2.1 SIEMENS STROMBERG-CARLSON DCO-E/DCO-SE
(Page 1 of 3)

Example

1000 LINES AT 3.2 CCS

		WATTS
1. CONTROL & MAINTENANCE FRAME POWER (CMF)		
DCO-E	1 X 2400	= 2400
DCO-SE	1 X 2000	= 2000

		WATTS
2. LOCAL LINE SWITCH FRAME (LLS) (DCO-E & DCO-SE)		
Quantity of Lines	1000 X 3.2 CCS/L X 0.069 (LOAD)	220.8
Quantity of Lines	1000 X 0.158 (IDLE)	= 158.0
Quantity of Line CUAs	12 X 30.0	= 360.0
Quantity of RLG Host CUAs	0 X 31.0	= 0
Quantity of SLC Host CUAs	0 X 158.0	= 0
Quantity of LLS Host CUAs	1 X 306.0	= 306.0
TOTAL LLS FRAME(S) POWER (WATTS)		=1044.8

3. LINE/TRUNK FRAME POWER (LTF) (DCO-E ONLY)		
Quantity of DTMF Receiver PWBAs	2 X 19.3	= 38.6
Quantity of DTMF Sender PWBAs	2 X 5.0	= 10.0
Quantity of TMF Receiver PWBAs	2 X 8.5	= 17.0
Quantity of TMF Sender PWBAs	2 X 3.9	= 7.8
Quantity of Busy Verification PWBAs	2 X 2.3	= 4.6
Quantity of Analog Trunk PWBAs	0 X 8.2	= 0
Quantity of LTF CUAs	2 X 19.3	= 38.6
TOTAL LTF POWER (WATTS)		= 116.6

4. DIGITAL TRUNK FRAME POWER (DTF) (DCO-E ONLY)		
Quantity of T1 Interface PWBAs	5 X 11.2	= 56.0
Quantity of Message Assemblers	0 X 57.3	= 0
Quantity of DTF CUAs	1 X 67.4	= 67.4
TOTAL DTF POWER (WATTS)		= 123.4

5. POWER RINGING & TEST FRAME POWER (PRTF) (DCO-E ONLY)		
Power Ringing & Test Frame	1 X 92.0	= 92.0
TOTAL PRTF POWER (WATTS)		= 92.0

Figure 2.1 SIEMENS STROMBERG-CARLSON DCO-E/DCO-SE
(Page 2 of 3)

Example

6. AMAF/DATA COLLECTION FRAME (AMAF/CODC) (DCO-E & DCO-SE)

	Quantity	Factor	WATTS
AMA Frame	____	X 495.0	= ____
CODC Data Collection Frame	____	X 523.0	= ____
TOTAL AMAF/DCF POWER (WATTS)			= 0

7. COMMON EQUIPMENT FRAME POWER (CEF) (DCO-E) & DCO-SE)

Variable (Dependent on OEM Equipment Installed)

TOTAL CEF POWER (WATTS) = 0

8. UNIVERSAL POWER FRAME (DCO-SE ONLY)

	Quantity	Factor	WATTS
Universal Power Frame (UPF)	1	X 92.0	= 92.0
Expanded Ringing CUA	____	X 70.0	= ____
*Universal Service CUA	____	X 155.0	= ____
*Universal Trunk/Service CUA	1	X 155.0	= 155.0
*Universal Trunk CUA	1	X 132.0	= 132.0
*Customber Trunk Group CUA	1	X 107.0	= 107.0
Quantity of DTMF Receiver PWBAs	2	X 19.3	= 38.6
Quantity of DTMF Sender PWBAs	2	X 5.0	= 10.0
Quantity of TMF Receiver PWBAs	2	X 8.5	= 17.0
Quantity of TMF Sender PWBAs	2	X 3.9	= 7.8
Quantity of Busy/Verification PWBAs	2	X 2.3	= 4.6
Quantity of Analog Trunk PWBAs	0	X 8.2	= 0
TOTAL UPF POWER (WATTS)			= 564.0

9. REMOTE LINE SWITCH POWER (RLS)

	Quantity	Factor	WATTS
RLS Frame (1080 Lines Maximum)	1	X 906.0	= 906.0
Quantity of Lines	1000 x 3.2 CCS/L	X 0.069	= 220.8
Quantity of Lines	1000	X 0.158	= 158.0
Quantity of Line CUAs	12	X 30.0	= 360.0
Quantity of RLG CUAs	____	X 31.0	= ____
Quantity of SLC CUAs	____	X 158.0	= ____
TOTAL RLS FRAME POWER (WATTS)			=1644.8

*ONLY 3 CUAs TOTAL CAN BE EQUIPPED

Figure 2.1 SIEMENS STROMBERG-CARLSON DCO-E/DCO-SE
(Page 3 of 3)

Example

10. REMOTE LINE SWITCH - 450 POWER (DC)	**WATTS**
TYPICAL Basic RLS-450 (Maximum)	= 1200
CUSTUMBER POWER (250W Maximum)	= 0
TOTAL RLS-450 DC POWER TOTAL WATTS (Maximum)	= 1200
RLS-450 Rated Ac Power Input (Typical)	= 6000

(Based on typical cold weather heating plus maximum short term system load.)

11. SYSTEM DC POWER SUMMARY

1. DCO-E SYSTEM POWER

Total Common Control Frame Power	=2400.0
Total Local Line Switch Power	=1044.8
Total Line/Trunk Frame Power	= 116.6
Total Digital Trunk Frame Power	= 123.4
Total Power Ringing & Test Frame Power	= 92.0
Total AMA/Data Collection Frame Power	= 0
Total Common Equipment Frame Power	= 0
TOTAL DCO-E SYSTEM DC POWER REQUIREMENTS	=3776.8
TOTAL DCO-E DC BUSY HOUR LOAD (TOTAL WATTS/52.1 VOLTS)	= 72.5 AMPS

12. DCO-SE SYSTEM POWER

Total Control & Maintenance Frame Power	=2000.0
Total Local Line Switch Frame Power	=1044.8
Total AMA/Data Collection Frame Power	= 0
Total Universal Power Frame Power	= 564.0
Total Common Equipment Frame Power	= 0
TOTAL DCO-SE SYSTEM DC POWER REQUIREMENTS	=3608.8
TOTAL DCO-SE DC BUSY HOUR LOAD (TOTAL WATTS/52.1 Volts)	= 69.3 AMPS

FIGURE 3 REDCOM MDX

DC DRAIN

	Quantity	Multiply By	Amps
MSU Shelves (One per 40 Lines)		3.5	

HEAT DISSIPATION

Heat Dissipation (Watts) = 52.1 x DC Drain ________ = ________ Watts

EXAMPLE
150 Lines

DC DRAIN

	Quantity	Multiply By	Amps
MSU Shelves (One per 40 Lines)	4	3.5	14

HEAT DISSIPATION

Heat Dissipation (Watts) = 52.1 x DC Drain 14 = 730 Watts

FIGURE 4 AT&T 5ESS SWITCH
(Page 1 of 2)

DC DRAIN

1.	Basic (AM and CM)		55.76
2.	No. of Disk Drive Units	_____ x 1.30 Amps	_____
3.	No. of Switching Modules w 32Mb Memory	_____ x 9.94 Amps	_____
4.	No. of MMSUs	_____ x 0.20 Amps	_____
5.	No. of LUs	_____ x 5.60 Amps	_____
6.	No. of TUs	_____ x 0.18 Amps	_____
7.	No. of DCTUs	_____ x 2.00 Amps	_____
8.	No. of GDSUs	_____ x 0.61 Amps	_____
9.	No. of DLTUs	_____ x 0.02 Amps	_____
10.	No. of DLTU Packs	_____ x 0.12 Amps	_____
	SUBTOTAL		_____
	Additional Drains		_____
	TOTAL DC Drain		_____

FIGURE 4 AT&T 5ESS SWITCH
(Page 2 of 2)

HEAT DISSIPATION

Type of Frame	Quantity	Heat Dissipation Per Frame (BTUs)	Total Heat Dissipation
Basic (AM and CM)	______	9931.42	______
No. of Disk Drives	______	231.54	______
No. of Switching Modules	______	1770.41	______
No. of MMSUs	______	36.27	______
No. of LUs	______	997.42	______
No. of TUs	______	32.95	______
No. of DCTUs	______	356.22	______
No of GDSUs	______	108.05	______
No. of DLTUs	______	174.55	______
TOTAL BTUs			______

FIGURE 4.1 AT&T 5 ESS SWITCH
(Page 1 of 2)

EXAMPLE
1 SM Office with 1000 Analog Lines,
12 Analog Trunks, and 192 Digital Trunk Circuits.

DC DRAIN

1.	Basic (AM and CM)		55.76
2.	No. of Disk Drive Units	4 x 1.30 Amps	5.20
3.	No. of Switching Modules w 32Mb Memory	1 x 9.94 Amps	9.94
4.	No. of MMSUs	11 x 0.20 Amps	2.20
5.	No. of LUs	3 x 5.60 Amps	16.80
6.	No. of TUs	4 x 0.18 Amps	0.72
7.	No. of DCTUs	1 x 2.00 Amps	2.00
8.	No. of GDSUs	3 x 0.61 Amps	1.83
9.	No. of DLTUs	1 x 0.02 Amps	0.02
10.	No. of DLTU Packs	8 x 0.12 Amps	0.96
	SUBTOTAL		95.43
	Additional Drains		
	TOTAL DC Drain		95.43

FIGURE 4.1 AT&T 5ESS SWITCH
(Page 2 of 2)

EXAMPLE
1 SM Office with 1000 Analog Lines,
12 Analog Trunks, and 192 Digital Trunk Circuits

HEAT DISSIPATION

Type of Frame	Quantity	Heat Dissipation Per Frame (BTUs)	Total Heat Dissipation
Basic (AM and CM)	1	9931.42	9931.42
No. of Disk Drives	4	231.54	926.16
No. of Switching Modules	1	1770.41	1770.41
No. of MMSUs	11	36.27	398.97
No. of LUs	3	997.42	2992.26
No. of TUs	4	32.95	131.80
No. of DCTUs	1	356.22	356.22
No of GDSUs	3	108.05	324.15
No. of DLTUs	1	174.55	174.55
TOTAL BTUs			17005.94

FIGURE 5 MITEL GX5000

D.C. DRAIN

EQUIPMENT	QUANTITY	MULTIPLY BY	WATTS
First peripheral pair and Main control (includes all features, AMA, matrix and first cabinet)	1	460	460
Additional peripheral pair	____	96	____
Additional cabinet	____	105	____
Single Party line card (16 ckts)	____	10	____
DS1 trunk card (2 spans)	____	29	____
Universal line card (6 ckts)	____	9	____

Total D.C. Drain ____ Watts

Converted to AMPS (Watts/Battery Voltage) = Watts/52 = ____ Amps

Heat dissipation = _____ Watts or (3.41 X ____Watts) = ____ BTU

FIGURE 5.1 MITEL GX5000

Example System: 1008 lines, 96 Digital Trunks

D.C. DRAIN

EQUIPMENT	QUANTITY	MULTIPLY BY	WATTS
First peripheral pair and Main control (includes all features, AMA, matrix and first cabinet)	1	460	460
Additional peripheral pair	2	96	192
Additional cabinet	1	105	105
Single Party line card (16 ckts)	63	10	630
DSI trunk card (2 spans)	2	29	58
Universal line card (6 ckts)	0	9	0

Total D.C. Drain 1,445 Watts

Converted to AMPS (Watts/Battery Voltage) = 1,445 Watts/52 = 27.7 Amps

Heat dissipation = 1,445 Watts or (3.41 X 1,445 Watts) = 4927 BTU

Figure 6 TRANSMISSION ELECTRONICS CURRENT DRAIN

Equipment	48-Volt Battery Drain Amperes Per Unit
Loop Extenders	0.075
VF Repeaters	
1. Negative Impedance	0.035
2. Hybrid	0.035
3. Automatic Gain Control	0.080
4. Loop Extender/Repeater Combination	0.100
5. Automatic Gain Control Loop Extender/Repeater Combination	0.200
Carrier Systems	
1. D1 or D2	3.0
2. D3 (24 Channel)	0.7
3. D4 (24 Channel)	0.35
4. T1 Span Line	0.6
5. Station Carrier (1 Channel)	0.04
6. Station Carrier (Multi-Channel) Per Channel	0.1
7. Pair Gain Devices (Switching) (See Notes 1 & 2 for Office End)	
Echo Canceller	
1. VF (1 Channel)	0.075
2. Digital (24 Channel)	1.7
Remote Office Line Test	
1. Test Console (110V ac, 0.4A)	0.7
2. Remote Terminal	0.7

Maintenance and Control Center	120V, 60Hz Load Amperes Per Unit (Note 3)
Co-located with COE:	
Video Display (CRT)	0.5
Printer (1200 Baud)	0.5
Remotely Located:	
Teletypwriter (e/w 300 Baud Modem)	0.35

NOTES:
1. Refer to the manufacturer's data sheets for specific current drain requirements.
2. Line concentrators or other pair gain devices incorporating switching functions are generally locally powered at remote site.
3. Voltage: 95 to 128V ac - Frequency: 48 to 65Hz

Figure 7 ESTIMATING TELEPHONE BATTERY SIZES

Number of Hours Reserve	8-Hour Ampere Hour Capacity Required for Each Ampere of Load — Final Cell Voltages 1.75	1.80	1.85	1.88	1.90	1.95
1	2.2	2.5	2.8	3.2	3.5	5.0
2	3.2	3.4	3.7	4.3	4.7	6.2
3	4.0	4.3	4.7	5.2	5.6	7.5
4	4.9	5.1	5.6	6.1	6.5	8.6
5	5.7	6.0	6.5	7.0	7.4	9.6
6	6.5	6.8	7.3	7.8	8.2	10.6
7	7.2	7.6	8.1	8.7	9.1	11.6
8	8.0	8.3	8.9	9.6	10.0	12.6
9	8.8	9.1	9.6	10.4	10.9	13.7
10	9.5	9.9	10.4	11.4	12.0	15.0
Voltage (24 Cells)	42	43.2	44.4	45.1	45.6	46.8

EXAMPLES:

1. Required: The capacity of a 24-cell battery to handle a 3-hour load of 34.0 amperes to a limited voltage of 45 volts.

$$45/24 = 1.88$$

From the above chart, each ampere of load requires 5.2 ampere hours of capacity.

Total capacity required = 5.2 x 34.0 = 177 ampere hours. Select next larger catalog size.

2. Calculate the ampere hour reserve of an existing 24-cell, 480-ampere hour battery with the load increased to 69 amperes to a final voltage of 1.88 volts.

Formula: $K = B/C$

Where

K = 8-hour ampere hour capacity required for each ampere of load.
B = Ampere hour capacity of existing battery.
C = Actual current drain of all equipment.

$$K = 480/69 = 7.0$$

On the chart, locate 7.0 in the 1.88-volt column and to the left read 5 hours of reserve.

FIGURE 8 CHARGER CAPACITY

The battery charger has to supply power for operation of the COE. Its capacity should be great enough to carry the entire load, including peak power requirements, to avoid taking power from the battery. Additional capacity is required to recharge the battery after a power service interruption.

EXAMPLE:

Drain	66 Amps
Battery Discharged for 3 Hours and Recharged in 12 Hours: 3 x 66 / 12 =	16.5 Amps
Calculated Charger DC Current Requirement	82.5 Amps
Rated Charger Capacity (as indicated in Paragraph 3.4)	75 Amps

The charger capacity sizes commercially available include:

2 @ 75 Amps	- Traditional arrangement with load sharing between the two chargers.
3 @ 50 Amps	- Potential cost saving over buying two larger units. Potential operating cost saving by operating only two units.

* U.S. G.P.O.:1993-300-090:80217/REA