POWER REQUIREMENTS FOR COMMUNITY CENTRAL OFFICE EQUIPMENT

Contents

1. GENERAL

1.1 This section 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 revision replaces REA TE&CM 302, Issue No. 5, dated January 1987. It is being reissued to include some new power calculation methods for various digital, stored program controlled central office equipment.

1.3 Paragraphs 12.1 and 12.2, respectively, of Part III, REA Form 522, "Specification for Digital, Stored Program Controlled Central Office Equipment," cover the general specifications governing the supply, by the manufacturer, of storage battery and charging equipment for use with an REA borrower's proposed central office equipment (COE). Based upon these general specifications, determination of the required capacities of the battery and charger is made by the manufacturer.

2. BASIS FOR CALCULATIONS

2.1 The charging equipment furnished with a central office must 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 REA TE&CM 320, "Emergency Generating and Charging Equipment." The computation of charger size to meet the site charging requirement is described in figure 10 - Charger Capacity.

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

(a) Two chargers either capable of carrying the full office load, or

(b) Three chargers each capable of carrying half the office load, or

Arrangement (a) may be used in any central office power system. Arrangement (b) may be used and offers 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 must have sufficient capacity to supply the dc power necessary to sustain satisfactory operation of the exchange for the period specified. See paragraph 1.3 for location of specific requirements in the central office equipment specifications. This includes appropriate allowances for any equipment which is normally ac operated but arranged for dc operation in case of a power failure.

2.3.2 During battery discharge, the minimum usable voltage to be delivered to the central office equipment is determined by the 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 the equipment design is based on 44 volts being available at the power entry to the bay. Performance of the COE at voltages less than 44 volts becomes unpredictable. The electromechanical systems used earlier were capable of operation at voltages below 40 volts.

The voltage drop to the equipment bay is controlled 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

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 9 - Estimating Telephone Battery Sizes. This method permits computation with differing numbers of hours of reserve and number of cells in the battery string. The computation is applicable to lead acid batteries - either lead antimony or lead calcium (see manufacturer's data for capacity, dimensions, etc.).

2.3.4 Battery capacities are generally given in terms of ampere hour (AH) rating, when discharged to 1.75 volts per cell, in an 8-hour period. Since many REA financed systems are equipped with emergency generators, the period of discharge of their batteries is reduced to 3 hours. When a battery is discharged at a rate faster than 8 hours, the ampere hour rating is effectively reduced, e.g., at 3 hours approximately 75 percent of the 8-hour rating is available. The net effect of the 3-hour discharge is to require a battery of approximately half the size required to carry the same load for 8 hours (3 x load in amps / 0.75 = 4 hours equivalent vs. 8-hour rating).

2.3.5 The selection of the battery capacity to be supplied is based on the power outages experienced at the site and 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 the system only requires power when in use. This gave rise to considering the power required in the "busy hour." Industry usage considered 8 busy hour battery capacity appropriate for most small installations. The expectation of 8 consecutive busy hours of usage following a power interruption was nil, 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 the digital switch 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 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 - AG	GTD No. 5 EAX
Figure 2 - Alcatel	1210/32, 64
Figure 3 - Alcatel	E10-FIVE
Figure 4 - Northern Telecom	DMS-100, DMS-10
Figure 5 - Stromberg-Carlson	DCO
Figure 6 - NEC America	NEAX 61 ES, 61EM
Figure 7 - Redcom	MDX

3.2 Figure 8: Lists various power requirements for loop extenders, voice frequency repeaters, carrier equipment and other equipment.

3.3 Figure 9: Illustrates the method used in determining the capacity of the storage battery required for a particular application. This exhibit also illustrates, in Example 2, a method used to calculate the ampere hour reserve of existing batteries when the current requirement of the central office equipment is changed as a result of equipment additions, higher than anticipated calling rates, etc.

3.4 Figure 10: Illustrates the method used in determining charger capacity required for a particular application. In connection with the calculation of the required capacity of the charger, a 10 percent allowance is made, i.e., if 110 percent of the rated output of the charger is equal to or greater than the calculated charger dc current requirement, the charger supplied shall be considered as satisfactorily meeting the specification requirements. Three 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 must 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 must be used for each individual application. It is, therefore, recommended that the manufacturer of the system be consulted for specific applications.

Figure 1 AG COMMUNICATION SYSTEMS GTD-5 EAX

DC POWER

1. Peripheral Equipment

<u>Line Power Consumption</u>:

5.56 to 7.20 CCS/line	Lines ______	x 1.02	=	______	Watts
4.00 to 5.55 CCS/line	Lines ______	x 0.90	=	______	Watts
0.00 to 3.99 CCS/line	Lines ______	x 0.78	=	______	Watts

<u>Analog Trunk Unit Power Consumption</u>:

5.56 to 7.20 CCS/line	Lines ______	x 0.00568	= ______		
4.00 to 5.55 CCS/line	Lines ______	x 0.004256	= ______		
0.00 to 3.99 CCS/line	Lines ______	x 0.00332	= ______		
Number of Analog Trunks			______		
Incoming MF CCS ______ x 0.00073			= ______		
Analog Trunk Unit Constant			92.00		
Analog Trunk Unit Total			______		
(Analog Trunk Unit Total/192)* x 805.23				= ______	Watts

<u>Digital Trunk Power Consumption</u>:

Office T1 Spans	______	x 15.07	= ______	Watts

2. Network Equipment

<u>Time Switch Power Consumption</u>:

5.56 to 7.20 CCS/line	Lines	______/ 750	= ______	
4.00 to 5.55 CCS/line	Lines	______/1128	= ______	
0.00 to 3.99 CCS/line	Lines	______/1520	= ______	
Analog Trunk Unit Total		______/ 192	= ______	
Office T1 Spans		______/ 8	= ______	
Total Time Switch Facility Interface Units			______	
(Time Switch FIU's ______/4)* x 669.19				= ______ Watts

<u>Space Switch Power Consumption</u>:

(Time Switch FIU's ______/4)* x 371.30 + 277 = ______ Watts

* All computations in parentheses must be rounded up to the nearest integer before proceeding.

Figure 1 AG GTD-5 EAX (Page 2)

3. Common Control Equipment

Processor Power Consumption:
(Busy Hour Attempts ______/45,000)* x 393.38 = ______ Watts

Office Memory Power Consumption:
Office Busy Hour Attempts:
Up to 45,000 BHA, Enter "0"
Up to 135,000 BHA, Enter "1"
Up to 180,000 BHA, Enter "2"
Up to 315,000 BHA, Enter "3"
148.75 + (Value Selected ______ x 29.17)* = ______ Watts

Message Distributor Power Consumption:
(Office Busy Hour Attempts ______/45,000)* = ______
(Time Switch FIU's ______/4)* = ______
Distributor Constant 1.00
Distributor Total Processors ______
(Distributor Total Processors ______/2)* x 35 + 57.44 = ______ Watts

Magnetic Tape Power Consumption:
Magnetic Tape Drives ______ x 173.52 = ______ Watts

4. GTD-5 Constant Power 1371.79 Watts

5. Miscellaneous Power 1000.00 Watts

6. Office Total Power ______ Watts

7. Heat Dissipation ______ Watts

8. DC Drain in Amperes
Office Total Power ______/50 = ______ Amperes

NOTES:
1) Use only for GTD-5 EAX's having fewer than 18,000 lines.
2) The office BHCA (e.g. 45,000) reflects a class 5 configuration without centrex capabilities.

* All computations in parentheses must be rounded up to the nearest integer before proceeding.

Figure 1 GTE COMMUNICATION SYSTEMS GTD-5 EAX

EXAMPLE #1

1,000 Lines @ 3.2 CCS/line, 50 Analog Trunks & 3 T1 Spans at 20 CCS/Trk.

DC POWER

1. Peripheral Equipment

Line Power Consumption:

5.56 to 7.20 CCS/line	Lines ______	x 1.02	= ______	Watts
4.00 to 5.55 CCS/line	Lines ______	x 0.90	= ______	Watts
0.00 to 3.99 CCS/line	Lines 1,000	x 0.78	= 780.00	Watts

Analog Trunk Unit Power Consumption:

5.56 to 7.20 CCS/line	Lines ______	x 0.00568	= ______		
4.00 to 5.55 CCS/line	Lines ______	x 0.004256	= ______		
0.00 to 3.99 CCS/line	Lines 1,000	x 0.00332	= 3.32		
Number of Analog Trunks			50.00		
Incoming MF CCS 921		x 0.00073	= 0.67		
Analog Trunk Unit Constant			92.00		
Analog Trunk Unit Total			145.99		
(Analog Trunk Unit Total/192)* x 805.23				= 805.23	Watts

Digital Trunk Power Consumption:

Office T1 Spans	3	x 15.07	= 45.21	Watts

2. Network Equipment

Time Switch Power Consumption:

5.56 to 7.20 CCS/line	Lines ______ / 750	= ______			
4.00 to 5.55 CCS/line	Lines ______ /1128	= ______			
0.00 to 3.99 CCS/line	Lines 1,000/1520	= 0.66			
Analog Trunk Unit Total	145.99/192	= 0.76			
Office T1 Spans	3 / 8	= 0.38			
Total Time Switch Facility Interface Units		1.80			
(Time Switch FIU's 1.8 /4)* x 669.19				= 669.19	Watts

Space Switch Power Consumption:

(Time Switch FIU's 1.80/4)* x 371.30 + 277	= 648.30	Watts

* All computations in parentheses must be rounded up to the nearest integer before proceeding.

Figure 1 GTE GTD-5 EAX (Page 2)

EXAMPLE #1

3. Common Control Equipment

Processor Power Consumption:
(Busy Hour Attempts 1,947/45,000) x 393.38 = 393.38 Watts

Office Memory Power Consumption:
Office Busy Hour Attempts:
Up to 45,000 BHA, Enter "0"
Up to 135,000 BHA, Enter "1"
Up to 180,000 BHA, Enter "2"
Up to 315,000 BHA, Enter "3"
148.75 + (Value Selected 0 x 29.17)* = 148.75 Watts

Message Distributor Power Consumption:
(Office Busy Hour Attempts 1,947/45,000)* = 1.00
(Time Switch FIU's 1.80/4)* = 1.00
Distributor Constant 1.00
Distributor Total Processors 3.00
(Distributor Total Processors 3/2)* x 35 + 57.44 = 127.44 Watts

Magnetic Tape Power Consumption:
Magnetic Tape Drives 2 x 173.52 = 347.04 Watts

4. GTD-5 Constant Power 1371.79 Watts

5. Miscellaneous Power 1000.00 Watts

6. Office Total Power 6336.33 Watts

7. Heat Dissipation 6336.63 Watts

8. DC Drain in Amperes
Office Total Power 6336.33/50 = 126.73 Amperes

NOTES:
1) Use only for GTD-5 EAX's having fewer than 18,000 lines.
2) The office BHCA (e.g. 45,000) reflects a class 5 configuration without centrex capabilities.

* All computations in parentheses must be rounded up to the nearest integer before proceeding.

Figure 1 GTE COMMUNICATION SYSTEMS GTD-5 EAX

EXAMPLE #2

2,152 Lines @ 3.2 CCS/line, 5 Analog Trunks & 11 T1 Spans at 20 CCS/Trk.

DC POWER

1. Peripheral Equipment

Line Power Consumption:

5.56 to 7.20 CCS/line	Lines ____	x 1.02	=	____	Watts
4.00 to 5.55 CCS/line	Lines ____	x 0.90	=	____	Watts
0.00 to 3.99 CCS/line	Lines 2152	x 0.78	=	1678.56	Watts

Analog Trunk Unit Power Consumption:

5.56 to 7.20 CCS/line	Lines ____	x 0.00568	=	____	
4.00 to 5.55 CCS/line	Lines ____	x 0.004256	=	____	
0.00 to 3.99 CCS/line	Lines 2152	x 0.00332	=	7.14	
Number of Analog Trunks				5.00	
Incoming MF CCS 2421 x 0.00073			=	1.77	
Analog Trunk Unit Constant				92.00	
Analog Trunk Unit Total				105.91	
(Analog Trunk Unit Total/192)* x 805.23				= 805.23	Watts

Digital Trunk Power Consumption:

Office T1 Spans	11	x 15.07	= 165.77	Watts

2. Network Equipment

Time Switch Power Consumption:

5.56 to 7.20 CCS/line	Lines	____ / 750	=	____		
4.00 to 5.55 CCS/line	Lines	____ /1128	=	____		
0.00 to 3.99 CCS/line	Lines	2152 /1520	=	1.42		
Analog Trunk Unit Total		105.91/ 192	=	0.55		
Office T1 Spans		11/ 8	=	1.38		
Total Time Switch Facility Interface Units				3.33		
(Time Switch FIU's 3.33 /4)* x 669.19					= 669.19	Watts

Space Switch Power Consumption:

(Time Switch FIU's 3.33/4)* x 371.30 + 277	= 648.30	Watts

* All computations in parentheses must be rounded up to the nearest integer before proceeding.

Figure 1 GTE GTD-5 EAX (Page 2)

EXAMPLE #2

3. Common Control Equipment

Processor Power Consumption:
(Busy Hour Attempts 4,494/45,000)* x 393.38 = 393.38 Watts

Office Memory Power Consumption:
Office Busy Hour Attempts:
Up to 45,000 BHA, Enter "0"
Up to 135,000 BHA, Enter "1"
Up to 180,000 BHA, Enter "2"
Up to 315,000 BHA, Enter "3"
148.75 + (Value Selected 0 x 29.17)* = 148.75 Watts

Message Distributor Power Consumption:
(Office Busy Hour Attempts 4,494/45,000)* = 1.00
(Time Switch FIU's 3.33 /4)* = 1.00
Distributor Constant 1.00
Distributor Total Processors 3.00
(Distributor Total Processors 3 /2)* x 35 + 57.44 = 127.44 Watts

Magnetic Tape Power Consumption:
Magnetic Tape Drives 2 x 173.52 = 374.04 Watts

4. GTD-5 Constant Power 1371.79 Watts

5. Miscellaneous Power 1000.00 Watts

6. Office Total Power 7355.45 Watts

7. Heat Dissipation 7355.45 Watts

8. DC Drain in Amperes
Office Total Power 7355.45/50 = 147.11 Amperes

Use only for GTD-5 EAX's having fewer than 18,000 lines.

* All computations in parentheses must be rounded up to the nearest integer before proceeding.

Figure 2 ALCATEL 1210/32, 1210/64

DC DRAIN

1210 Host:

________	Lines at 3 CCS x .032	=	________	Amps
________	Lines at 4 CCS x .035	=	________	Amps
________	Lines at 5 CCS x .038	=	________	Amps
	Add 60 Amps	=	60	Amps
	Add Customer DC Requirements	=	________	Amps
	Total DC Drain	=	________	Amps

1210 Remote Line Switch:

________	Lines at 3 CCS x .026	=	________	Amps
________	Lines at 4 CCS x .030	=	________	Amps
________	Lines at 5 CCS x .034	=	________	Amps
	Add 7 Amps	=	7	Amps
	Add Customer DC Requirements	=	________	Amps
	Total DC Drain	=	________	Amps

1210 Remote Switching Unit:

________	Lines at 3 CCS x .033	=	________	Amps
________	Lines at 4 CCS x .036	=	________	Amps
________	Lines at 5 CCS x .039	=	________	Amps
	Add 22 Amps	=	22	Amps
	Add Customer DC Requirements	=	________	Amps
	Total DC Drain	=	________	Amps

HEAT DISSIPATION

Total DC Drain x 51.8 Volts = ________ Watts

Figure 2 ALCATEL 1210/32, 1210/64

EXAMPLE

DC DRAIN

1210 Host: 1,000 Lines

1000	Lines at 3 CCS x .032	=	32	Amps
____	Lines at 4 CCS x .035	=	____	Amps
____	Lines at 5 CCS x .038	=	____	Amps
	Add 60 Amps	=	60	Amps
	Add Customer DC Requirements	=	____	Amps
	Total DC Drain	=	92	Amps

1210 Remote Line Switch: 2,100 Lines

2100	Lines at 3 CCS x .026	=	55	Amps
____	Lines at 4 CCS x .030	=	____	Amps
____	Lines at 5 CCS x .034	=	____	Amps
	Add 7 Amps	=	7	Amps
	Add Customer DC Requirements	=	____	Amps
	Total DC Drain	=	62	Amps

1210 Remote Switching Unit: 6,000 Lines

6000	Lines at 3 CCS x .033	=	198	Amps
____	Lines at 4 CCS x .036	=	____	Amps
____	Lines at 5 CCS x .039	=	____	Amps
	Add 22 Amps	=	22	Amps
	Add Customer DC Requirements	=	____	Amps
	Total DC Drain	=	220	Amps

HEAT DISSIPATION (Example is for 1000 line host office)

Total DC Drain x 51.8 Volts = 92 x 51.8 = 4766 Watts

Figure 3 ALCATEL E10-FIVE

DC DRAIN

EQUIPMENT	QUANTITY	MULTIPLY BY	AMPS
Total Lines (Idle Drain)	________	.005	________
Total Lines (Occupied Drain)	________	.0012 x CCS	________
Control TCU Cabinet	________	12.94	________
Matrix Cabinet (Up to 5000L)	________	7.67	________
Common Equipment (Up to 4000L)	________	10.0	________
Line Cabinet	________	.44	________
AMA	________	8.36	________
Miscellaneous OEM	________		________
T1 (24 Channel)	________	1.08	________
(48 Channel)	________	1.85	________
(72 Channel)	________	2.62	________
(96 Channel)	________	3.40	________
		TOTAL AMPS	________
		CUSTOMER DRAIN	________

HEAT DISSIPATION

Heat Dissipation (WATTS) 51.2 x DC Drain = ________ Watts

BTU/Hour = 3.41 x Watts

Figure 3 ALCATEL E10-FIVE

EXAMPLE
2,000 Lines @ 3.2 CCS/Line

DC DRAIN

EQUIPMENT	QUANTITY	MULTIPLY BY	AMPS
Total Lines (Idle Drain)	2000	.005	10.0
Total Lines (Occupied Drain)	2000	.0012 x CCS	7.68
Control TCU Cabinet	1	12.94	12.94
Matrix Cabinet (Up to 5000L)	1	7.67	7.67
Common Equipment (Up to 4000L)	1	10.0	10.0
Line Cabinet	3	.44	1.32
AMA		8.36	
Miscellaneous OEM	1 ea		10.0
T1 (24 Channel)		1.08	
(48 Channel)		1.85	
(72 Channel)		2.62	
(96 Channel)	2	3.40	6.8
		TOTAL AMPS	66.41
		CUSTOMER DRAIN	

HEAT DISSIPATION

Heat Dissipation (WATTS) 51.2 x DC Drain = 3400.2 Watts

BTU/Hour = 3.41 x Watts
BIU/Hour = 3.41 x 3400.2
BTU/Hour = 11,595

Figure 4-1 NORTHERN TELECOM DMS-100

DC DRAIN

1. Basic (CPU) — 78.5
   CC Frame E/W 4 Memory Shelves
   I/O Frame E/W 2 Disk + 1 Mag Tape
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 9.2 Amps — _______
7. MTM _______ x 3.3 Amps — _______
8. TM _______ x 2.2 Amps — _______
9. LGC _______ x 9.3 Amps — _______
10. Line Circuits

    9x (Avg. 2-Way ABSBH CCS/Line / 8)x No. of LCM __+

    +1 + (5x (Avg. 2-W ABSBH CCS/Line / 8)x No. of LCE __+

    +3.6 + (4.2 x (Avg. 2-W ABSBH CCS/Line / 8)x No. of LCM __ = _______

Subtotal _______

Customer Drain _______ — _______

DMS Current Total _______ — _______

CC - Central Controller
PDC - Power Distribution Center
DTC - Digital Trunk Controller
LGC - Line Group Controller
MTM - Maintenance Trunk Module
TM - Trunk Module

Figure 4-1 NORTHERN TELECOM DMS-100

EXAMPLE

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 9.2 Amps	9.2
7.	MTM 4 x 3.3 Amps	13.2
8.	TM 1 x 2.2 Amps	2.2
9.	LGC 1 x 9.3 Amps	9.3
10.	Line Circuits	

$$9 \times \left(\frac{\text{Avg. 2-Way ABSBH CCS/Line } 3.2}{8}\right) \times \text{LCM } 2 +$$

$$+1 + \left(\frac{5x\ (\text{Avg. 2-W ABSBH CCS/Line } 3.2}{8}\right) \times \text{LCE } 1 +$$

$$+3.6 + \left(\frac{4.2 \times (\text{Avg. 2-W ABSBH CCS/Line } 3.2)}{8}\right) \times \text{LCM } 2 = \quad 17.16$$

Subtotal	160.06
Customer Drain 20	20
DMS Current Total	180.06

CC - Central Controller
PDC - Power Distribution Center
DTC - Digital Trunk Controller
LGC - Line Group Controller
MTM - Maintenance Trunk Module
TM - Trunk Module

Figure 4-1 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 4-1 NORTHERN TELECOM DMS-100

EXAMPLE

1400 Lines, 50 Digital Trunks, 50 Analog Trunks, 3.2665/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 e/w	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 4-2 DMS-10 D.C. CURRENT DRAIN

Figure 4-2 NORTHERN TELECOM STANDARD DMS-10 400 SERIES

DC DRAIN

Basic System

DCM Shelves	______	x	4	=	______ Amps
DCI Shelf	______	x	3	=	______ Amps
SCM-10S	______	x	10	=	______ Amps
P.E. Shelf	______	x	0.75	=	______ Amps
LCE Lines	______	x	0.015	=	______ Amps
BMC	______	x	5	=	______ Amps
D.C./A.C. Inverter (0.5 KW)					______ Amps
			Total	=	______ Amps

Heat Dissipation

D.C. Drain

Northern Telecom DMS-10 400 Generic (3 Bay)

Basic System

P.E. Shelf	______	x	0.75	=	______ Amps
DCM Shelf	______	x	4	=	______ Amps
LCE Lines	______	x	0.015	=	______ Amps
			Total		______ Amps

Heat Dissipation

D.C. Drain	______	x	52	______ Watts

DMS-10 D.C. CURRENT DRAIN

Figure 4-2 NORTHERN TELECOM STANDARD DMS-10 400 SERIES

Example #1

Northern Telecom Standard DMS-10 400 Series

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

DC Drain

Basic System					25	Amps
DCM Shelves	4	x	4	=	16	Amps
DCI Shelf	1	x	3	=	3	Amps
SCM-10S	1	x	10	=	10	Amps
P.E. Shelf	2	x	0.75	=	1.5	Amps
LCE Lines	5000	x	0.015	=	75	Amps
BMC	2	x	5	=	10	Amps
D.C./A.C. Inverter (0.5 KW)					15	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	Amps
P.E. Shelf	2	x	0.75	=	1.5	Amps
DCM Shelf	1	x	4	=	4	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

DMS-10 D.C. CURRENT DRAIN

Figure 4-2 NORTHERN TELECOM STANDARD DMS-10 400 SERIES

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

DMS-10 D.C. CURRENT DRAIN (Page 2)

Figure 4.2 NORTHERN TELECOM STANDARD DMS-10 400 SERIES

5 - OPM	AMPS
One Cabinet	15
Line Current	0.015/L

6 - OPSM	AMPS
One Cabinet	9
Line Current	0.015/L

7 - RSLM	AMPS
RSLM Bay	6
Line Current	0.015/L

8 - RSLE	AMPS
RSLE Bay (up to 512 lines)	10.5
RSLE Bay (from 512 to 1024 lines)	21
Line Current	0.015/L

9 - RLCM	AMPS
RLCM Bay	10
LCE Bay	0.015/L

DAT - Digital Analog Trunk
DCM - Digital Carrier Module
DCI - Digital Carrier Interface
GPIO - General Purpose Input Output
LCE - Line Concentrating Equipment (uses 6X___ type circuits)
OPM - Outside Plant Module
OPSM - Outside Plant Subscriber Module
PCCM - Power Cooling Control Module
P.E. - Peripheral Equipment (uses 2T___ type circuits)
RLCM - Remote Line Concentrator Module
RSLM - Remote Subscriber Line Module
RLSE - Remote Line Subscriber Equipment
SCM - Subscriber Carrier Module
T&M - Trunk and Maintenance

FIGURE 5 STROMBERG-CARLSON DCO

DC DRAIN

1. DCO Frame Power Calculations

Local Line Switch Power:

Quantity of Lines = ________ x		CCS/L	x 0.696	=	________
Quantity of Lines	=	________	x 0.1583	=	________
Quantity of Line CUAs	=	________	x 27.91	=	________
Quantity of RLG Host CUAs	=	________	x 145.4	=	________
Quantity of SLC-96 (Mode 1) CUAs	=	________	x 130.5	=	________
Quantity of SLC-96 (Mode 2) CUAs	=	________	x 123.3	=	________
Quantity of LLS Frames	=	________	x 2.52	=	________

TOTAL LLS POWER REQUIREMENTS ________ WATTS

Line/Trunk Frame Power:

Quantity of DTMF Receiver PWBAs	=	________	x 9.39	=	________
Quantity of TMF Receiver PWBAs	=	________	x 6.90	=	________
Quantity of TMF Sender PWBAs	=	________	x 2.39	=	________
Quantity of Busy Verif. PWBAs	=	________	x 14.46	=	________
Quantity of Analog Trunk PWBAs	=	________	x 8.2	=	________
Quantity of LTF CUAs	=	________	x 18.53	=	________

TOTAL LTF POWER REQUIREMENTS ________ WATTS

Digital Trunk Frame Power:

Quantity of Tl Interface PWBAs	=	________	x 16.0	=	________
Quantity of Message Assem. PWBAs	=	________	x 46.88	=	________
Quantity of DTF CUAs	=	________	x 73.36	=	________

TOTAL DTF POWER REQUIREMENTS ________ WATTS

CMF/CCEF Power:

Quantity of TSI PWBAs	=	________	x 123.0	=	________
Quantity of MP's	=	________	x 229.57	=	________
Quantity of Memory PWBAs	=	________	x 15.61	=	________
Quantity of RNSs (7 Max)	=	________	x 56.82	=	________
Quantity of Sectors (4 Max)	=	________	x 492.9	=	________
CMF Common Drain				=	724.19

TOTAL CMF/CCEF POWER REQUIREMENTS ________ WATTS

Figure 5 STROMBERG-CARLSON DCO (Page 2)

Power, Ringing & Test Frame Power:

Preferential Ringing Frequencies	= ________	x 52	=	________
First PRT Frame			=	104
Second PRT (> 2 Sectors)	= ________	x 92	=	________

TOTAL PRT POWER REQUIREMENTS ________ WATTS

AMA/CODC Power:

AMA Frame	= ________	x 392	=	________
CODC Data Collector Frame	= ________	x 586	=	________

TOTAL AMA/CODC POWER REQUIREMENTS ________ WATTS

Common Equipment Frame Power:

Item/Model No.	Quantity	Power

TOTAL CEF POWER REQUIREMENTS ________ WATTS

Miscellaneous Equipment Power:

Item/Model No.	Quantity	Power

TOTAL MISCELLANOUS EQUIPMENT
POWER REQUIREMENTS ________ WATTS

Figure 5 StROMBERG-CARLSON DCO (Page 3)

2. DCO System DC Power Summary

Total Local Line Switch Power	________	WATTS
Total Digital Trunking Power	________	WATTS
Total Line/Trunk Frame Power	________	WATTS
Total CMF/CCEF Power	________	WATTS
Total Power, Ringing and Test Power	________	WATTS
Total AMA/CODC Power	________	WATTS
Total Common Equipment Frame Power	________	WATTS
Total Miscellaneous Equipment Power	________	WATTS
Total Customer's Equipment Power	________	WATTS
TOTAL DCO SYSTEM DC POWER REQUIREMENTS	________	WATTS
TOTAL DC BUSY HOUR LOAD (________ WATTS/52.1 Volts)	________	AMPS

3. RLS Frame Power Calculations

<u>Remote Line Switch Power:</u>

Quantity of Lines = ________	x	CCS/L	x .0696	=	________
Quantity of Lines	=	________	x 0.1583	=	________
Quantity of Line CUAs	=	________	x 27.91	=	________
Quantity of RLG Host CUAs	=	________	x 145.4	=	________
Quantity of SLC-96 (Mode 1) CUAs	=	________	x 130.5	=	________
Quantity of SLC-96 (Mode 2) CUAs	=	________	x 123.3	=	________
Quantity of ESS Feature	=	________	x 75.0	=	________
Quantity of PGHs	=	________	x 13.6	=	________
Quantity of RLS I Frames	=	________	x 683.24	=	________
Quantity of RPRF	=	________	x 166.0	=	________

TOTAL RLS POWER REQUIREMENTS ________ WATTS

TOTAL DC BUSY HOUR LOAD (________WATTS/52.1 Volts) ________ AMPS

Figure 5 STROMBERG-CARLSON DCO

EXAMPLE
1,000 Lines, 3.2 CCS

DC DRAIN

1. DCO Frame Power Calculations

Local Line Switch Power:

Quantity of Lines = 1000 x 3.2 CCS/L		x .069	=	221
Quantity of Lines	= 1000	x 0.1583	=	158
Quantity of Line CUAs	= 12	x 27.91	=	335
Quantity of RLG Host CUAs	= 0	x 145.4	=	0
Quantity of SLC-96 (Mode 1) CUAs	= 0	x 130.5	=	0
Quantity of SLC-96 (Mode 2) CUAs	= 0	x 123.3	=	0
Quantity of LLS Frames	= 1	x 2.52	=	2.52

TOTAL LLS POWER REQUIREMENTS 717 WATTS

Line/Trunk Frame Power:

Quantity of DTMF Receiver PWBAs	= 3	x 9.39	=	28
Quantity of TMF Receiver PWBAs	= 2	x 6.90	=	14
Quantity of TMF Sender PWBAs	= 3	x 2.39	=	7
Quantity of Busy Verif. PWBAs	= 2	x 14.46	=	29
Quantity of Analog Trunk PWBAs	= 3	x 8.2	=	25
Quantity of LTF CUAs	= 2	x 18.53	=	37

TOTAL LTF POWER REQUIREMENTS 140 WATTS

Digital Trunk Frame Power:

Quantity of T1 Interface PWBAs	= 5	x 16.0	=	80
Quantity of Message Assem. PWBAs	= 0	x 46.88	=	0
Quantity of DTF CUAs	= 1	x 73.36	=	73

TOTAL DTF POWER REQUIREMENTS 153 WATTS

CMF/CCEF Power:

Quantity of TSI PWBAs	= 2	x 123.0	=	246
Quantity of MP's	= 1	x 229.57	=	230
Quantity of Memory PWBAs	= 2	x 15.61	=	31
Quantity of RNSs (7 Max)	= 0	x 56.82	=	0
Quantity of Sectors (4 Max)	= 1	x 492.9	=	493
CMF Common Drain			=	724.19

TOTAL CMF/CCEF POWER REQUIREMENTS 1724 WATTS

Figure 5 STROMBERG-CARLSON DCO (Page 2)

EXAMPLE

Power, Ringing & Test Frame Power:

Preferential Ringing Frequencies	= 4	x 52	= 208	
First PRT Frame			= 104	
Second PRT (> 2 Sectors)	=	x 92	=	
TOTAL PRT POWER REQUIREMENTS		312	WATTS	

AMA/CODC Power:

AMA Frame	=	x 392	=
CODC Data Collector Frame	=	x 586	=
TOTAL AMA/CODC POWER REQUIREMENTS			WATTS

Common Equipment Frame Power:

Item/Model No.	Quantity	Power
Digital Recorded Announcer		64
Test Generator		55

TOTAL CEF POWER REQUIREMENTS 119 WATTS

Miscellaneous Equipment Power:

Item/Model No.	Quantity	Power

TOTAL MISCELLANOUS EQUIPMENT POWER REQUIREMENTS 0 WATTS

Figure 5 STROMBERG-CARLSON DCO (Page 3)

EXAMPLE

2. DCO System DC Power Summary

Total Local Line Switch Powr	717	WATTS
Total Digital Trunking Power	153	WATTS
Total Line/Trunk Frame Power	140	WATTS
Total CMF/CCEF Power	1724	WATTS
Total Power, Ringing and Test Power	304	WATTS
Total AMA/CODC Power	0	WATTS
Total Common Equipment Frame Power	119	WATTS
Total Miscellaneous Equipment Power	0	WATTS
Total Customer's Equipment Power	0	WATTS
TOTAL DCO SYSTEM DC POWER REQUIREMENTS	3157	WATTS
TOTAL DC BUSY HOUR LOAD (3165 WATTS/52.1 Volts)	60.7	AMPS

3. RLS Frame Power Calculations

Remote Line Switch Power:

Quantity of Lines = 1000 x 3.2 CCS/L		x .069	=	221
Quantity of Lines	=	1000 x 0.1583	=	158
Quantity of Line CUAs	=	12 x 27.91	=	335
Quantity of RLG Host CUAs	=	0 x 145.4	=	0
Quantity of SLC-96 (Mode 1) CUAs	=	0 x 130.5	=	0
Quantity of SLC-96 (Mode 2) CUAs	=	0 x 123.3	=	0
Quantity of ESS Feature	=	1 x 75.0	=	75
Quantity of PGHs	=	4 x 13.6	=	54
Quantity of RLS I Frames	=	1 x 683.24	=	683
Quantity of RPRF	=	1 x 166.0	=	166

TOTAL RLS POWER REQUIREMENTS 1692 WATTS

TOTAL DC BUSY HOUR LOAD (1692 WATTS/52.1 Volts) 32.5 AMPS

Figure 6-1 NEC America NEAX 61ES

DC DRAIN

	Quantity	Multiply By	Amps
Idle Switch Drain			30.50
Time Switch Frames(1)		14	
Digital Transmission Interface(2)		1.3	
Line & Trunk Frames		9	
Analog Trunks		0.02	
Total Busy Hour Traffic (CCS)		0.001	
Customer Drain			
TOTAL DC DRAIN			

NOTES:

(1) 1 per 2880 ports.

(2) 1 per five T1 span lines.

HEAT DISSIPATION

Heat Dissipation (Watts) = 52.7 x DC Drain ________ = ________ Watts

Figure 6-1 NEC America NEAX 61ES

EXAMPLE
1,000 Lines, 50 Digital Trunks, 50 Analog Trunks, 3.2 CCS/L

DC DRAIN

	Quantity	Multiply By	Amps
Idle Switch Drain			30.50
Time Switch Frames(1)	1	14	14
Digital Transmission Interface(2)	1	1.3	1.3
Line & Trunk Frames	2	9	18
Analog Trunks	50	0.02	1
Total Busy Hour Traffic (CCS)	3200	0.001	3.2
Customer Drain			20
TOTAL DC DRAIN			88

NOTES:

(1) 1 per 2880 ports.

(2) 1 per five T1 span lines.

HEAT DISSIPATION

Heat Dissipation (Watts) = 52.7 x DC Drain 88 = 4637.6 Watts

Figure 6-2 NEC America NEAX 61EM

DC DRAIN

	Quantity	Multiply By	Amps
Idle Switch Drain			37.50
Time Switch Frames(1)		14	
Digital Transmission Interface(2)		1.3	
Line & Trunk Frames		9	
Analog Trunks		0.02	
Total Busy Hour Traffic (CCS)		0.001	
Customer Drain			
TOTAL DC DRAIN			

NOTES:

(1) 1 per 2880 ports.

(2) 1 per five T1 span lines.

HEAT DISSIPATION

Heat Dissipation (Watts) = 52.7 x DC Drain ________ = ________ Watts

Figure 6-2 NEC America NEAX 61EM

EXAMPLE

1,000 Lines, 50 Digital Trunks, 50 Analog Trunks, 3.2 CCS/L

DC DRAIN

	Quantity	Multiply By	Amps
Idle Switch Drain			37.50
Time Switch Frames(1)	1	14	14
Digital Transmission Interface(2)	1	1.3	1.3
Line & Trunk Frames	2	9	18
Analog Trunks	50	0.02	1
Total Busy Hour Traffic (CCS)	3200	0.001	3.2
Customer Drain			20
TOTAL DC DRAIN			95

NOTES:

(1) 1 per 2880 ports.

(2) 1 per five T1 span lines.

HEAT DISSIPATION

Heat Dissipation (Watts) = 52.7 x DC Drain 95 = 5006.50 Watts

FIGURE 7 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 8 TRANSMISSION ELECTRONICS CURRENT DRAIN

	48-Volt Battery Drain Amperes Per Unit
Equipment	
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. N1 or N2	1.8
6. N3 (24 Channel)	3.0
7. Station Carrier (1 Channel)	0.04
8. Station Carrier (Multi-Channel) Per Channel	0.1
9. 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)
Colocated 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 9 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' reserve.

Figure 10 CHARGER CAPACITY

The battery charger must 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.

<u>EXAMPLE</u>:

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 item 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.

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APPENDIX A

POWER REQUIREMENTS FOR DIRECT CONTROL AND COMMON CONTROL ELECTROMECHANICAL SWITCHING SYSTEMS

1. GENERAL

1.1 The power requirements described in this appendix are for the older electromechanical switching systems that are still in use. These computations may be used in estimating power requirements associated with additions or rearrangements of the existing switching systems.

2. CALCULATIONS

2.1 Attached Exhibits A through N outline the procedures to be followed in calculating the power requirements (charger and battery) for dial central office equipment of the following types:

EXHIBIT A - Switch Type Equipment as Manufactured by Automatic Electric, ITT and Stromberg-Carlson

North Electric NX-2A Crossbar Equipment

Leich All-Relay Equipment

EXHIBIT B - Stromberg-Carlson ESC-1

EXHIBIT C - Stromberg-Carlson ESC-3

EXHIBIT D - ITT A-1

EXHIBIT E - ITT PC-32B

EXHIBIT F - Automatic Electric CXP-5

EXHIBIT G - Automatic Electric No. 1 EAX

EXHIBIT H - North Electric NX-1D

EXHIBIT I - North Electric NX-1E

EXHIBIT J - Northern Electric SP-1

EXHIBIT K - Nippon Electric NC-23, NC-400, and NC-460

EXHIBIT L - Stromberg-Carlson Toll Ticketing

EXHIBIT M - ITT Tel Touch

EXHIBIT N - Stromberg-Carlson Tone Dialing

EXHIBIT A

Busy Hour Current Drain Calculations
for Various Switchboards
(All Values in Amperes)

Type of Drain	Switch Type (XY, SxS)	North NX-2A Crossbar	Leich Dial (Linefinder-Selector-Connector)
Equipment Holding (See Note 1)	0.72/T.C.U.	0.6/T.C.U. (See Note 5)	1.17/T.C.U.
General Operating	0-100 Lines 1.0 101-200 Lines 1.5 201-400 Lines 2.0 401+ Lines 3.0	1st Line Group 1.0 Each Add'l. Line Group 0.5	4.0
Additional Equipment	-	-	0.3/100 Lines
Manual Toll Board	2.0/Position	2.0/Position	2.0/Position
DC Operated Ringing Generator (See Note 2)	0-100 Lines 2.0 101+ Lines 3.0	3.0	0-100 Lines 2.0 101+ Lines 3.0
Interoffice Trunk Circuit	0.35/2W & 1W Incoming Trunk 0.30/1W Outgoing Trunk (See Note 4)	0.25/Trunk (See Note 4)	1.08/T.T.C.U. (See Note 6)
Special Equipment (See Note 3)	As Required	As Required	As Required

EXHIBIT A NOTES

Notes:

1. A "Time Call" Unit is calculated as follows:

$$\text{T.C.U.} = \frac{\text{Unit Calls Per Line X Total Number of Lines}}{36}$$

2. When the primary ringing generator is ac operated, no provision need be made in the charger capacity to handle the standby ringing generator. The generator drain must be included when calculating battery capacity.

3. This includes the power requirements for carrier, loop extenders, voice frequency repeaters, ANI, etc. Where special equipment is normally ac operated and requires dc only for standby, no provision need be made in the charger capacity. The drain must be included when calculating battery capacity.

4. If the number of interoffice trunk groups equals four or more for switch type equipment (more than four for NX-2A), it is satisfactory to use three-quarters (3/4) of the total trunk circuit current drain.

5. When conversation time disconnect is equipped, add 0.2 amperes per T.C.U. to the holding drain.

6. A Trunk "Time Call" Unit (T.T.C.U.) is calculated as follows:

$$\text{T.T.C.U.} = \frac{\text{Unit Call Capacity of Trunk Group (P.01)}}{36}$$

7. If the total busy hour drain is not in excess of ten percent above a standard charger size, that charger may be used. If the above total exceeds ten percent, the next larger standard charger size should be used.

Examples:

The following office will be used in each of these examples. Assume a 360 line office has a calling rate of 2.0 unit calls per line with 6 two-way toll trunks and 8 two-way EAS trunks terminated on incoming selectors. Also assume that dc operated carrier and VF repeaters have a drain of 3 amperes. The primary ringing generator is ac operated in Examples 1 and 3.

$$\text{T.C.U.} = \frac{\text{2.0 UC/L X 360 Lines}}{36} = 20$$

Exhibit A Examples Continued

1. Switch Type Equipment:

Equipment Holding Drain = 20 X 0.72	= 14.4
General Operating Drain	= 2.0
No Toll Board	-
Primary Ringing Generator - AC Operated	-
Trunk Drain = 14 X 0.35	= 4.9
Special Equipment Drain	= 3.0
Total Drain	24.3 Amps

2. North NX-2A Crossbar:

Equipment Holding Drain = 20 X 0.6	= 12.0
General Operating Drain = $1.0 + \frac{270}{90} \times 0.5$	= 2.5
Primary Ringing Generator - DC Operated	= 3.0
Trunk Drain = 14 X 0.25	= 3.5
Special Equipment Drain	= 3.0
Total Drain	24.0 Amps

3. Leich Dial:

Equipment Holding Drain = 20 X 1.17	= 23.4
General Operating Drain	= 4.0
Additional Equipment Drain = $\frac{360}{100} \times 0.3$	= 1.1
Primary Ringing Generator - AC Operated	-
Trunk Drain:	
6 Toll Trunks (P.01) will handle 64.4 UC	
Toll Group Drain = $\frac{64.4}{36} \times 1.08$	= 1.9
8 EAS Trunks (P.01) will handle 105 UC	
EAS Group Drain = $\frac{105}{36} \times 1.08$	= 3.2
Special Equipment Drain	= 3.0
Total Drain	36.6 Amps

The above total drains should be used in determining charger size. For calculating battery capacity three amperes should be added to Examples 1 and 3 to account for ringing generator current drain.

EXHIBIT B

Stromberg-Carlson ESC-1

Equipment	48-Volt Drain			8-Volt Drain		
	No. of Units	Amperes Per Unit	Total Current	No. of Units	Amperes Per Unit	Total Current
Common Control (Local) Cabinets (CCL) [1]	-	-	-		16	
4-Stage Trunk Link Network (TLN)		93		-	-	-
6-Stage Trunk Link Network (TLN)		102		-	-	-
Common Control (Trunk) Cabinets (CCT)		10			7	
Register Sender Cabinets (RS)		1			10	
Auxiliary Register Sender Cabinets (RSA)		3			10	
Translator Cabinets	-	5	5	-	42	42
TLN Cabinet (Control) (TLC)	1	10	10	1	8	8
Supervisory Cabinet (CSR)	1	6	6	1	12	12
Powerboard (1 Frequency)		7		-	-	-
(2 Frequencies)		9		-	-	-
(4 Frequencies)		15		-	-	-
Automatic Call Generator	1	3	3	1	5	5
DC-DC Converter (-24v) [2]		11		-	-	-
Loop Extender Power Supply [2]		4		-	-	-
Pre-Pay Power Supply		2		-	-	-
Tandem Trunks [3]		.015		-	-	-
Recording Trunks		Note 4			Note 4	
LAMA Cabinets		24			16	
CAMA Cabinets		13			7	
Maintenance Test Console		5			2	
Registers	-	-	-		1	
Senders	-	-	-		1	
Customer Drain		As Req'd.			As Req'd.	
Total Drain	48-Volt			8-Volt		

EXHIBIT B NOTES

Notes:

1. When the number of line units are odd, round off to next even number.

2. Do not include drain for redundant equipment.

3. Incoming Tandem Trunk   CCS X .015 = Total Current

4.

Recording Trunks Equipped	Drain in Amperes 48-Volt	8-Volt
1 - 50	7	57
51 - 100	8	68
101 - 150	9	79
151 - 200	10	90
201 - 250	11	102
251 - 300	13	113
301 - 350	14	124
351 - 400	15	136

5. When SCAMA-LAMA ticketing is required, the following drains should be added:

Ultimate DDD Trunk Capacity	8V Drain	48V Drain
50	57 amps	7 amps
100	68	8
150	79	9
200	90	10
250	111	11
300	113	13
350	124	14
400	136	15

6. When CAMA is required, the following drains should be added:

48V Drain - 24 amps
8V Drain - 16 amps

EXAMPLE

Stromberg-Carlson ESC-1
1500 Lines
5000 Directory Numbers

Equipment	48-Volt Drain			8-Volt Drain		
	No. of Units	Amperes Per Unit	Total Current	No. of Units	Amperes Per Unit	Total Current
Common Control (Local) Cabinets (CCL) 1	-	-	-	1	16	16
4-Stage Trunk Link Network(TLN)	1	93	93	-	-	-
6-Stage Trunk Link Network(TLN)		102		-	-	-
Common Control(Trunk) Cabinets (CCT)	1	10	10	1	7	7
Register Sender Cabinets(RS)	1	1	1	1	10	10
Auxiliary Register Sender Cabinets (RSA)		3			10	
Translator Cabinets	-	5	5	-	42	42
TLN Cabinet(Control) (TLC)	1	10	10	1	8	8
Supervisory Cabinet (CSR)	1	6	6	1	12	12
Powerboard (1 Frequency)		7		-	-	-
(2 Frequencies)		9		-	-	-
(4 Frequencies)	1	15	15	-	-	-
Automatic Call Generator	1	3	3	1	5	5
DC-DC Converter (-24v) 2	1	11	11	-	-	-
Loop Extender Power Supply 2	2	4	8	-	-	-
Pre-Pay Power Supply	2	2	4	-	-	-
Tandem Trunks 3	100 CCS	.015	1.5	-	-	-
Recording Trunks		Note 4			Note 4	
LAMA Cabinets		24			16	
CAMA Cabinets	1	13	13	1	7	7
Maintenance Test Console	1	5	5	1	2	2
Registers	-	-	-	80	1	80
Senders	-	-	-	20	1	20
Customer Drain		As Req'd.	15		As Req'd.	
Total Drain		48-Volt	200.5		8-Volt	209

EXHIBIT C

Stromberg-Carlson ESC-3

Equipment	48-Volt Drain No. of Units	48-Volt Drain Amperes Per Unit	48-Volt Drain Total Current	8-Volt Drain No. of Units	8-Volt Drain Amperes Per Unit	8-Volt Drain Total Current
Common Control Cabinet		23.8			48.6	
Translator		4.2			77.7	
Test Cabinet		3.7			10.0	
Power Supervisory		24.7		-	-	-
Register Common	-	-	-		12.0	
Call Generator		0.6			4.8	
MF Current Supply		2.8		-	-	-
Each Register (Max. 48)		0.2			1.3	
Each Sender (Max. 20)	-	-	-		1.0	
Each Tone Dial Detector		0.43		-	-	-
Each 1,000 Directory Numbers	-	-	-		5.6	
Each Toll MF Detector		0.5		-	-	-
+48v Message Registration		3.5		-	-	-
+48v Paystation Coin Control		1.5		-	-	-
Aux. Common Control Cabinet		6.8			16.6	
Aux. Line/Trunk Marker		4.2			14.0	
Each Line Unit (1350 CCS)		20.3		-	-	-
Each Line Unit (2000 CCS)		30.0		-	-	-
Loop Extender Power Supply (3 amps per 49 loops)		3.0		-	-	-
Customer Drain		As Req'd.			As Req'd.	
Total Drain	48-Volt			8-Volt		

EXAMPLE

Stromberg-Carlson ESC-3
500 Lines
1000 Directory Numbers

Equipment	48-Volt Drain			8-Volt Drain		
	No. of Units	Amperes Per Unit	Total Current	No. of Units	Amperes Per Unit	Total Current
Common Control Cabinet	1	23.8	23.8	1	48.6	48.6
Translator	1	4.2	4.2	1	77.7	77.7
Test Cabinet	1	3.7	3.7	1	10.0	10.0
Power Supervisory	1	24.7	24.7	-	-	-
Register Common	-	-	-	1	12.0	12.0
Call Generator	1	0.6	.6	1	4.8	4.8
MF Current Supply	1	2.8	2.8	-	-	-
Each Register (Max. 48)	8	0.2	1.6	8	1.3	10.4
Each Sender (Max. 20)	-	-	-	5	1.0	5.0
Each Tone Dial Detector		0.43		-	-	-
Each 1,000 Directory Numbers	-	-	-	1	5.6	5.6
Each Toll MF Detector		0.5		-	-	-
+48v Message Registration		3.5		-	-	-
+48v Paystation Coin Control		1.5		-	-	-
Aux. Common Control Cabinet		6.8			16.6	
Aux. Line/Trunk Marker		4.2			14.0	
Each Line Unit (1350 CCS)	1	20.3	20.3	-	-	-
Each Line Unit (2000 CCS)		30.0		-	-	-
Loop Extender Power Supply (3 amps per 49 loops)	1	3.0	3.0	-	-	-
Customer Drain		As Req'd.	10.0		As Req'd.	
Total Drain	48-Volt		94.7	8-Volt		174.1

EXHIBIT D

ITT A-1 Pentaconta

I. Speech Path Drain

CCS (Intraoffice)		x 0.007 =	
CCS (Outgoing)		x 0.007 =	
CCS (Incoming)		x 0.008 =	
		Total	

= Speech Path Drain

II. Register-Sender Drain

	BHC	RHT	BHCx RHT		
Intraoffice Calls				x 0.0008	
Outgoing Calls					
Assistance					
CAMA					
TSPS					
EAS					
Other					
Total Outgoing				x 0.0014 =	
Incoming Calls					
DDD					
EAS					
Other					
Total Incoming				x 0.0008 =	
				Total	

= R-S Drain

BHC = Number of Busy Hour Calls
RHT = Register-Sender Holding Time

Exhibit D - Continued

III. Marker Drain

BHC (Intraoffice)		x 0.0085 =	
BHC (Outgoing)		x 0.0026 =	
BHC (Incoming)		x 0.0057 =	
		Total	

= Marker Drain

IV. Connector Drain

Total Marker Drain		x 0.2 =	

= Connector Drain

V. Customer Equipment Drain

As Required

Total Current Drain equals sum of I through V.

EXHIBIT E

ITT PC-32B

I. Speech Path Drain

CCS (Intraoffice)		x 0.022 =	
CCS (Outgoing)		x 0.017 =	
CCS (Incoming)		x 0.017 =	
		Total	

Total = Speech Path Drain

II. Register-Sender Drain

	BHC	RHT	BHC x RHT		
Intraoffice Calls				x 0.00014 =	
Outgoing Calls					
Assistance					
CAMA					
TSPS					
EAS					
Other					
Total Outgoing				x 0.00021 =	
Incoming Calls					
DDD					
EAS					
Other					
Total Incoming				x 0.00056 =	
				Total	

Total = R-S Drain

BHC = Number of Busy Hour Calls
RHT = Register-Sender Holding Time

Exhibit E continued

III. Marker Drain

BHC (Intraoffice)				
BHC (Outgoing)				
BHC (Incoming)				
Total BHC		x 0.0019 =		= Marker Drain

IV. Customer Equipment Drain

As Required

Total Current Drain Equals Sum of I through IV.

ITT A-1 Pentaconta & PC-32B

Example

The following information is used to demonstrate the method used to calculate the current drain of the ITT A-1 and PC-32B systems.

2000 Lines		
1.6 CCS/Line Originating		
Outgoing Trunk Traffic		
Assistance	200 CCS	67 BHC
CAMA	400 CCS	167 BHC
EAS	800 CCS	533 BHC
Incoming Trunk Traffic		
DDD	600 CCS	250 BHC
EAS	800 CCS	533 BHC
Intraoffice Traffic	1800 CCS	1500 BHC

Register Holding Times	
Assistance	5 Seconds
CAMA	17 Seconds
Outgoing EAS	14 Seconds
DDD	7 Seconds
Incoming EAS	7 Seconds
Intraoffice	14 Seconds

Customer Equipment Drain 40 Amps

EXAMPLE

ITT A-1 Pentaconta

I. Speech Path Drain

CCS (Intraoffice)	1800	x 0.007 =	12.6
CCS (Outgoing)	1400	x 0.007 =	9.8
CCS (Incoming)	1400	x 0.008 =	11.2
		Total	33.6

= Speech Path Drain

II. Register-Sender Drain

	BHC	RHT	BHC x RHT		
Intraoffice Calls	1500	14	21,000	x 0.0008	16.8
Outgoing Calls					
Assistance	67	5	335		
CAMA	167	17	2839		
TSPS					
EAS	533	14	7462		
Other					
Total Outgoing	767		10,636	x 0.0014 =	14.9
Incoming Calls					
DDD	250	7	1750		
EAS	533	7	3731		
Other					
Total Incoming	783		5481	x 0.0008 =	4.4
				Total	36.1

= R-S Drain

BHC = Number of Busy Hour Calls
RHT = Register-Sender Holding Time

EXAMPLE - Continued

III. Marker Drain

BHC (Intraoffice)	1500	x 0.0085 =	12.8
BHC (Outgoing)	767	x 0.0026 =	2.0
BHC (Incoming)	783	x 0.0057 =	4.5
		Total	19.3

= Marker Drain

IV. Connector Drain

Total Marker Drain	19.3	x 0.2 =	3.9

= Connector Drain

V. Customer Equipment Drain

As Required 40 AMPS

Total Current Drain equals sum of I through V.

33.6 + 36.1 + 19.3 + 3.9 + 40.0 = 132.9 AMPS

From the above ampere drain it is seen that either two 150 amp chargers or three 75 amp chargers should be provided. For a three-hour reserve, a 660 ampere-hour battery is required. (From Exhibit P, a final cell voltage of 1.85 yields a factor of 4.7 for a three-hour reserve. Therefore, 4.7 X 132.9 = 625 AH. The next larger size is 660 AH.)

EXAMPLE

ITT PC-32B

I. Speech Path Drain

CCS (Intraoffice)	1800	x 0.022 =	39.6
CCS (Outgoing)	1400	x 0.017 =	23.8
CCS (Incoming)	1400	x 0.017 =	23.8
		Total	87.2

= Speech Path Drain

II. Register-Sender Drain

	BHC	RHT	BHC x RHT		
Intraoffice Calls	1500	14	21,000	x 0.00014 =	2.9
Outgoing Calls					
Assistance	67	5	335		
CAMA	167	17	2839		
TSPS					
EAS	533	14	7462		
Other					
Total Outgoing	767		10,636	x 0.00021 =	2.2
Incoming Calls					
DDD	250	7	1750		
EAS	533	7	3731		
Other					
Total Incoming	783		5481	x 0.00056 =	3.1
				Total	8.2

= R-S Drain

BHC = Number of Busy Hour Calls
RHT = Register-Sender Holding Time

EXAMPLE continued

III. Marker Drain

BHC (Intraoffice)	1500			
BHC (Outgoing)	767			
BHC (Incoming)	783			
Total BHC	3050	x 0.0019 =	5.8	= Marker Drain

IV. Customer Equipment Drain

As Required 40 AMPS

Total Current Drain Equals Sum of I through IV.

87.2 + 8.2 + 5.8 + 40.0 = 141.2 AMPS

EXHIBIT F

Automatic Electric CXP-5

Subscriber Lines x CCS/Line =

_________ x _________ = ___________

Delay Dial Trunks CCS = ___________
Local Register-Sender CCS = ___________
Non-Delay Dial Trunk Register-Sender CCS = ___________

Total CCS = ___________

0.037 x Total CCS = Peak BH Drain
0.037 x _________ = ___________ (A)

Trunks (See Note)

Type	Number		Drain
1W Incoming DD	_________	x 0.30 =	_________
1W Incoming NDD	_________	x 1.25 =	_________
2W DD	_________	x 0.15 =	_________
2W NDD	_________	x 0.62 =	_________
CAMA or SATT	_________	x 0.14 =	_________
Coin Completion	_________	x 0.35 =	_________

Total Trunk Drain _________ (B)

Note: Do not include 1-way outgoing trunks other than CAMA or SATT.

DD = Delay Dial
NDD = Non-Delay Dial

Common Equipment

Common Control and General Office Drain 6.0
Ringing Generators (5 Freq. 15W-3A, 25W-5A, 50W-13A) _______
(1 Freq. 15W-0.6A, 25W-1A, 50W-1.8A)

Detection Equipment (Type 70A - 4 amps/system) _______
Customer Equipment (Carrier, loop extenders, etc.) _______

Total Common Equipment Drain _______ (C)

Total CXP-5 Drain = 0.8 x [A + B + C]
= 0.8 x _________ = _________

Automatic Electric
CXP-5

Example

The following information is used to demonstrate the method used to calculate the current drain of the Automatic Electric CXP-5 system.

2000 Lines
1.6 CCS/Line Originating
Delay Dial Trunks CCS 1000
Local Register Sender CCS 1800
Non-Delay Dial Trunk Register-Sender CCS 400
10 1W Incoming DD Trunks
5 1W Incoming NDD Trunks
20 2W DD Trunks
5 2W NDD Trunks
15 CAMA Trunks
5 Coin Completion
Ringing Generator - 5 Frequency - 25 Watt
One 70A System
40 amps Customer Equipment

EXAMPLE

Automatic Electric CXP-5

Subscriber Lines x CCS/Line =
2000 x 1.6 = 3200

Delay Dial Trunks CCS = 1000
Local Register-Sender CCS = 1800
Non-Delay Dial Trunk Register-Sender CCS = 400

Total CCS = 6400

0.037 x Total CCS = Peak BH Drain
0.037 x 6400 = 236.8 (A)

Trunks (See Note)

Type	Number		Drain
1W Incoming DD	10	x 0.30 =	3.0
1W Incoming NDD	5	x 1.25 =	6.3
2W DD	20	x 0.15 =	3.0
2W NDD	5	x 0.62 =	3.1
CAMA or SATT	15	x 0.14 =	2.1
Coin Completion	5	x 0.35 =	1.8

Total Trunk Drain 19.3 (B)

Note: Do not include 1-way outgoing trunks other than CAMA or SATT.

DD = Delay Dial
NDD = Non-Delay Dial

Common Equipment

Common Control and General Office Drain 6.0
Ringing Generators (5 Freq. 15W-3A, 25W-5A, 50W-13A) 5.0
(1 Freq. 15W-0.6A, 25W-1A, 50W-1.8A)

Detection Equipment (Type 70A - 4 amps/system) 4.0
Customer Equipment (Carrier, loop extenders, etc.) 40.0

Total Common Equipment Drain 55.0 (C)

Total CXP-5 Drain = 0.8 x [A + B + C]
= 0.8 x 311.1 = 248.9

Exhibit G

Automatic Electric No. 1 - EAX

Line Drain

Number of lines x 0.027 amps/line (A)

Trunk Drain

Number of trunks x 0.15 amps/trunks (B)

Busy Hour Drain = A + B = (C)
Peak Busy Hour Drain = 1.33 x C = (D)

Common Control Drain

Up to 15,000 lines - 250 amps (E)
More than 15,000 lines - 510 amps

Customer Equipment Drain

As Required (F)

Total Busy Hour Drain = C + E + F

Total Peak Busy Hour Drain (Power Board) = D + E + F

Example: The following information is used to demonstrate the method for calculating the busy hour current drain of the Automatic Electric No. 1 - EAX:

4000 Lines — 800 Trunks — 100 Amps, Customer Equipment Drain

Calculation:

4000 lines x 0.027 amps/line	=	108 amps
800 trunks x 0.15 amps/trunk	=	120 amps
Busy Hour Drain		228 amps

Peak Busy Hour Drain = 1.33 x 228 = 303.2 amps

Common Control Drain = 250 amps
Customer Equipment Drain = 100 amps

Total Busy Hour Drain = 228+250+100 = 578 amps
Total Peak Busy Hour Drain = 303.2+250+100 = 653.2 amps

EXHIBIT H

North Electric NX-1D

Formula 1 for Class 5 offices - includes all trunks:

Average BH Current Drain =
Number of Lines x CCS per line x 0.025 amperes

__________ x __________ x 0.025 = __________

Customer Equipment Drain = __________

Total Drain = __________

Formulae for Class 4/5 offices or Class 5 offices with ticketing:

1. Line Group Drain =
   Number of Lines x CCS per line x 0.014 amperes
   __________ x __________ x 0.014 = __________

2. One-way trunk, excluding intertoll, Drain =
   Trunks CCS x 0.01 amperes
   __________ x 0.01 = __________

3. Two-way, and one-way intertoll, trunk Drain =
   Trunks CCS x 0.0174 amperes
   __________ x 0.0174 = __________

4. Toll Recording Trunk Drain =
   Trunks CCS x 0.05 amperes
   __________ x 0.05 = __________

5. TSD Equipment Drain =
   TSD CCS x 0.015 amperes
   __________ x 0.015 = __________

6. Customer Equipment Drain = __________

Total Drain = 1 + 2 + 3 + 4 + 5 + 6 = __________

Calculating drain for Group Selector, Translator and Number Group:

Group Selector and Translator
1.5 amps per frame

Number Group
1.0 amp per frame

EXHIBIT I

North NX-1E

The current drain for the electromechanical portion of the NX-1E is calculated in the same manner as the NX-1D. To calculate the drain of the electronic part of the NX-1E, the following figures should be used:

Uprights Fully Equipped	Average Drain Per Upright
Receiver-Sender Originating (RSO)	11 amps
RSO - Auxiliary	7
Receiver-Sender Incoming (RSI)	10
Key Call Receiver/MF Receiver (KCR/MFR) (Assume all MFR's)	4
KCR/MFR Auxiliary (Assume all MFR's)	4
KCR/MFR (Assume all KCR's)	6
KCR/MFR Auxiliary (Assume all KCR's)	7
Key Call/MF Receiver Link (MFL)	3
Trunk Register Link (TRL)	6
500-Line Group	Number of Lines x UC/L x 0.0075
3-Stage Group Selector	14
CPU Pair	17
Data Memory	15
Miscellaneous Data Transfer Unit	3
Tape Unit	5

North NX-1D and NX-1E

Example

The following data is used to demonstrate the method used to calculate the current drain of the North NX-1D and the electromechanical portion of the NX-1E. The necessary information to calculate the required drain of the NX-1E electronic circuits is shown in Exhibit I.

Class 5 Office		
2000 Lines		
2.0 CCS/Line Originating		
Customer Equipment Drain	40 Amps	
Class 5 Office with Ticketing		
2000 Lines		
2.0 CCS/Line Originating		
100 Two-Way Intertoll Trunks		2800 CCS
100 Two-Way EAS Trunks		2800 CCS
75 One-Way Toll Completing Trunks		2000 CCS
75 One-Way Intertoll Trunks		2000 CCS
125 Toll Recording Trunks		3600 CCS
12 TSD Positions		1200 CCS
Customer Equipment Drain	40 Amps	

EXAMPLE

North Electric NX-1D

Formula 1 for Class 5 offices - includes all trunks:

Average BH Current Drain =
Number of Lines x CCS per line x 0.025 amperes

2000 x 2.0 x 0.025 = 100
Customer Equipment Drain = 40
Total Drain = 140

Formulae for Class 4/5 offices or Class 5 offices with ticketing:

1. Line Group Drain =
   Number of Lines x CCS per line x 0.014 amperes
   2000 x 2.0 x 0.014 = 56.0

2. One-way trunk, excluding intertoll, Drain =
   Trunks CCS x 0.01 amperes
   2000 x 0.01 = 20.0

3. Two-way, and one-way intertoll, trunk Drain =
   Trunks CCS x 0.0174 amperes
   7600 x 0.0174 = 132.2

4. Toll Recording Trunk Drain =
   Trunks CCS x 0.05 amperes
   3600 x 0.05 = 180.0

5. TSD Equipment Drain =
   TSD CCS x 0.015 amperes
   1200 x 0.015 = 18.0

6. Customer Equipment Drain = 40.0

Total Drain = 1 + 2 + 3 + 4 + 5 + 6 = 446.2

EXHIBIT J

Northern Electric SP-1 (2 Wire)

I. Negative 48-Volt Current Consumption

Constant		125 amps
Total Busy Hour Calls / 1000 x 1 amp (Minimum 10 amperes)	=	
Incoming CCS x 0.01	=	
Outgoing CCS x 0.00925	=	
Originating Intraoffice CCS x 0.0145	=	________
Total Negative 48-Volt Current Drain	=	

Notes:

1. In offices with short loops, add 20 amperes per 10,000 lines. Where loops are long, subtract 20 amperes per 10,000 lines.
2. For offices with Centrex features, add 25 amperes.

II. Positive 24-Volt Current Consumption

A.	Common Equipment (CPU's, CCTC, PMC, etc.)	42.0 amps
B.	Call Stores:	
	Ferrite Sheet Memory, Basic 16K Words	10.8 amps
	, First Supplementary 8K Words	8.0 amps
	, Second Supplementary 8K Words	2.8 amps
	MOS Memory, Basic 16K Words	5.1 amps
	, Supplementary 8K Words	1.3 amps
C.	Program and Data Stores:	
	Piggyback Twister Memory, Basic 16K Words	5.2 amps
	, Supplementary 16K Words	2.2 amps
	MOS Memory, Basic 32K Words	13.8 amps
	, Supplementary 16K Words	5.2 amps
D.	Centrex Data Line Units (16 Data Lines)	8.0 amps
E.	LAMA	3.0 amps
F.	Per 1000 Line Appearances	1.0 amps

Northern Electric SP-1

Example

The following data is used to demonstrate the method of calculating the negative 48-volt current drain of the Northern Electric SP-1 system.

Total Busy Hour Calls (Originating and Terminating) 12,000 BHC
Incoming CCS 3000 CCS
Outgoing CCS 3000 CCS
Originating Intraoffice CCS 4000 CCS

The majority of subscriber loops are 1900 ohms or less.

EXAMPLE

Northern Electric SP-1 (2 Wire)

I. Negative 48-Volt Current Consumption

Constant			125 amps
Total Busy Hour Calls x 1 amp / 1000 (Minimum 10 amperes)	12,000 / 1000 x 1	=	12
Incoming CCS x 0.01	3000 x .01	=	30.0
Outgoing CCS x 0.00925	3000 x .00925	=	27.8
Originating Intraoffice CCS x 0.0145	4000 x 0.45	=	58.0
Total Negative 48-Volt Current Drain		=	252.8
Add for short loops			+ 20.0
			272.8

Notes:

1. In offices with short loops, add 20 amperes per 10,000 lines. Where loops are long, subtract 20 amperes per 10,000 lines.

2. For offices with Centrex features, add 25 amperes.

EXHIBIT K

Nippon Electric Crossbar Systems (NC-10, NC-23, NC-400 and NC-460)

I. Negative 48-Volt Main Power Requirement

A. Average Current Drain

$$Iav = (A+B) \times C \times \frac{K}{36} \quad \text{where}$$

Iav = Average Current in Amperes
A = Originating CCS Per Line
B = Terminating CCS Per Line
C = Number of Lines
K = 0.41 for NC-10
K = 0.51 for NC-23
K = 0.53 for NC-400 and NC-460

B. Peak Current Drain

$$Ipk = Iav + 4.48 \sqrt{Iav} \quad \text{where}$$

Ipk = Peak Current in Amperes
Iav = Average Current in Amperes

II. Positive 50-Volt Power Requirement

A. 0.58 amps per Dial Tone Marker (NC-400)

B. 1.42 amps per Completing Marker (NC-400)

C. 1.42 amps per Marker (NC-23, NC-460)

Nippon Electric Crossbar Systems

Example

The following data is used to demonstrate the method of calculating the current drain for the NC-10, NC-23, NC-400 and NC-460 systems.

Originating CCS Per Line	1.6 CCS/Line
Terminating CCS Per Line	1.6 CCS/Line
Number of Lines	2000 Lines
Dial Tone Markers (NC-400)	3
Completing Markers (NC-400)	3
Markers (NC-23, NC-460)	3

Negative 48-volt Main Power Requirement:

NC-10

$$Iav = (1.6 + 1.6) \times 2000 \times \frac{.41}{36} = 73 \text{ amps}$$

$$Ipk = 73 + 4.48\sqrt{73} = 111.3 \text{ amps}$$

NC-23

$$Iav = (1.6 + 1.6) \times 2000 \times \frac{.51}{36} = 90.7 \text{ amps}$$

$$Ipk = 90.7 + 4.48\sqrt{90.7} = 133.3 \text{ amps}$$

NC-400 and NC-460

$$Iav = (1.6 + 1.6) \times 2000 \times \frac{.53}{36} = 94.2 \text{ amps}$$

$$Ipk = 94.2 + 4.48\sqrt{94.2} = 137.7 \text{ amps}$$

Positive 50-volt Power Requirement:

NC-23 and NC-460

$$3 \times 1.42 = 4.26 \text{ amps}$$

NC-400

$$3 \times 0.58 + 3 \times 1.42 = 6 \text{ amps}$$

EXHIBIT L

Power Requirements for Stromberg-Carlson Toll Ticketing Equipment

The following busy hour current drains should be used when calculating power requirements for Stromberg-Carlson automatic toll ticketing equipment:

1.0 ampere per recorder
2.0 amperes per identifier (usually 1 identifier)
4.0 amperes per data register (1 register/3.5 trunks)
2.0 amperes per sender (1 sender/4 recorders)
4.0 amperes miscellaneous

Example:

An automatic toll ticketing system contains the following equipment: 17 recorders, 1 identifier, 4 data registers and 4 senders.

The following drains are totaled:

Recorders	17 x 1.0	=	17	
Identifier	1 x 2.0	=	2	
Data Registers	4 x 4.0	=	16	
Senders	4 x 2.0	=	8	
Miscellaneous			4	
Total Drain			47	amperes

EXHIBIT M

ITT Tel Touch

The following formulae should be used to calculate the additional busy hour current drain when ITT Tel Touch (pushbutton dialing) equipment is installed:

1. Total Originating Call Drain

$$\frac{\text{Total Originating Traffic (UC)} \times 0.046}{36} = \underline{\hspace{3em}} \text{ amps}$$

2. Traffic to Register Drain*

$$\frac{\text{BHC} \times \text{Register Holding Time}}{3600} \times (\text{Register Current} + 0.04) = \underline{\hspace{3em}} \text{ amps}$$

$$\text{BHC} = \frac{\text{Unit Calls} \times 100}{\text{Call Holding Time}}$$

Register Holding Time (RHT) =
2.5 + (1.5 seconds/digit x number of digits)

*Repeat this calculation for each type of traffic to registers, i.e., local, toll, CAMA, EAS, etc.

Register Current Table

Number of Digits Handled	Current
1	1.2
2	1.2
3	1.5
4	1.5
5	1.65
6	1.65
7	2.0
8	2.0
9	2.3
10	2.3
11	2.55
12	2.55
13	2.8

Exhibit M Continued-2

3. Allotter Drain

Total BHC x 0.00047 = __________ amps

4. Peak Drain

Total Drain (1 + 2 + 3) x 1.03 = __________ amps

Example:

A 300-line office equipped with 100% Tel Touch has the following traffic parameters:

Total Originating Traffic = 300 lines x 1.4 UC/L = 420 UC
9 Toll Trunks = 126 UC ÷ 2 = 63 UC
7 EAS Trunks = 84 UC ÷ 2 = 42 UC

Equal traffic is assumed in both directions on 2-way trunks.

Total Local Originating Traffic = 420 - (63 + 42) = 315 UC

Assume 120 second holding time.

$$\text{Local Originating BHC} = \frac{315 \times 100}{120} = 263 \text{ BHC}$$

Toll holding time is assumed to be 270 seconds.

$$\text{Toll Originating BHC} = \frac{63 \times 100}{270} = 23 \text{ BHC}$$

EAS holding time is assumedto be 150 seconds.

$$\text{EAS Originating BHC} = \frac{42 \times 100}{150} = 28 \text{ BHC}$$

Local Traffic - 7 Digits
Toll Traffic - 1 Digit
EAS Traffic - 7 Digits

Register Holding Time (RHT) - Local and EAS = 2.5 + (1.5x7) = 13 seconds

Register Holding Time (RHT) - Toll = 2.5 + (1.5x1) = 4 seconds

Exhibit M Continued-3

The following shows the calculation of the busy hour current drain:

1. Total Originating Call Drain = $\frac{420 \times .046}{36}$ = .54 amps

2. Local Traffic to Register Drain = $\frac{263 \times 13}{3600} \times (2+.04)$ = 1.94 amps

   EAS Traffic to Register Drain = $\frac{28 \times 13}{3600} \times (2+.04)$ = .21 amps

   Toll Traffic to Register Drain = $\frac{23 \times 4}{3600} \times (1.2+.04)$ = .03 amps

3. Allotter Drain = (263 + 28 + 23) x .00047 = .15 amps

   Total Drain = 2.87

4. Peak Drain = 2.87 x 1.03 = 3.0 amps

EXHIBIT N

Stromberg-Carlson Tone Dialing

To calculate the current drain of Stromberg-Carlson tone dialing equipment, use one ampere for each converter.

To calculate the number of converters required, use the following formula:

$$\frac{\text{Number of Lines} \times \text{UC/L}}{\text{Avg. Call Holding Time}} \times \text{Average Converter Holding Time} = \text{UC to Converters}$$

Using the P.01 Table, find the number of converters required.

Example:

Given:
- 400 Lines
- 1.5 UC/L
- Call Holding Time - 180 seconds
- Converter Holding Time - 10 seconds

Find current drain of Tone Dialing equipment.

Using the above formula, the traffic to the converters is

$$\frac{400 \times 1.5}{180} \times 10 = 33.3 \text{ UC}$$

From the P.01 Table, 5 converters are required. Therefore, the current drain is

$$5 \times 1 \text{ amp/converter} = 5 \text{ amps}$$