

## IN-SERVICE REQUIREMENTS

### NO. 1/1A, 2/2B, AND 3 ELECTRONIC SWITCHING SYSTEMS

### GENERAL PROCEDURES

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<b>1. GENERAL</b>		
1.01 This section describes the general procedures used in calculating in-service requirements for a No. 1/1A, 2/2B, or 3 ESS*. The in-service requirement calculation should be used by maintenance forces in determining the number of circuits of a component type that may be removed from service for maintenance		

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**2.04** Therefore, it is necessary for the maintenance forces to be made aware of the minimum in-service requirements throughout the business day in established periods. Generally these periods will cover a busy season, a modification period or a general transition period. Individual needs will be established locally.

**2.05** Since the network administrator is charged with ensuring that sufficient in-service equipment is available to meet service objectives, the statement of in-service requirements is prepared by the network administrator.

**2.06** The in-service requirement determination is used to produce an Allowable Equipment Out of Service (EOS) report that is provided to the switching control center (SCC). This report is prepared at least annually, before the start of the busy season or as required by local practice. A copy is provided to each SCC responsible for the operation of each switching entity.

### **3. DETERMINATION OF IN-SERVICE REQUIREMENTS**

**3.01** The statement of in-service requirements is established for control of both corrective and preventive maintenance needs. Maintenance operations requiring equipment out of service are, when possible, generally planned out of the the major switch busy hours. However, substantial traffic loads do occur outside these regular measured periods.

**3.02** To ensure that sufficient quantities of equipment are available throughout any day of the studied period, three load data groupings of service categories (A, B, and C) have been established. These categories are used to set the minimum number of circuits in service for each group of components studied for three time groupings. As a complement, the study may state the maximum limit of circuits (by component) that may be removed from service. The description of each category is as follows:

(a) *Category A:* Includes all hours at 85 to 100 percent of the average busy season (ABS) component load

(b) *Category B:* Includes all hours in which the component load is greater than 65 percent but less than 85 percent of the ABS component load.

(c) *Category C:* Includes all other hours of observed data, i.e., 65 percent or less of the ABS component load.

**3.03** The hourly load referred to in each category represents an average business day, time-consistent hour.

**3.04** The basic hour data used for determining in-service requirements may be obtained from the latest busy hour determination study (BHD). A description of BHD is contained in Section 780-200-031. The BHD is used to indicate which hours of the day fall into each of the three load/service categories. Mechanized data summary systems, such as the Central Office Equipment Report (COER), will aid in the collection of such data. The COER system provides a set of User Lessons that describe the reports and the summation process. The COER is available for 1/1A and 2/2B ESS. The H-Schedule data (posted hourly) must be used for a 3 ESS switch.

### **Capacity Determination Worksheets**

**3.05** A recent capacity determination study may be used as a basis for the CCS/or Call load data on the in-service requirement forms. If the capacity determination was a review of the latest busy season, the usage factors (CCS/MS or TRUNK (TK), etc.) must be adjusted for the expected load of the in-service requirement study period. The adjustment of the usage factors should be made with the assistance of the traffic engineer. For details on capacity determination studies see Section 231-060-130 for 1/1A ESS, Section 232-060-130 for 2/2B ESS, and Section 233-060-130 for 3ESS.

**3.06** The capacity determination worksheets are also used as a source for the engineering criterion for each component.

**3.07** The quantity of equipment installed is obtained from the capacity determination worksheets, if there is no planned equipment addition between the last busy season review and the period of the in-service requirement study. If there is a planned equipment study, a copy of the network design order should be referenced for equipment quantities.

**Note:** The equipment quantities installed used for the in-service requirement study represent total quantities, those provided for traffic as well as those provided for service protection margin.

## Forecasts - Main Stations/Trunks

**3.08** The most recent main station forecast for the in-service study period as shown in the **General Planning Forecast** should be obtained from the traffic engineer. When dealing with a multi-entity wire center the most recent **Loading Plan** for the entity being studied should be referenced.

**3.09** Trunk forecasts for the study period should be obtained from the circuit provisioning forces.

## Engineering Criterion

**3.10** The engineering criterion, the base time period for which the component is engineered [ABS, 10 high day (HD) or HD] and the service criterion (Poisson capacity table, P.001, P.01. etc.), for each component may be obtained from the most recent capacity determination study or the traffic engineer.

## 4. PREPARATION OF THE STUDY

**4.01** Figures 1 and 2 provide an example of the in-service requirement study for an hypothetical office. Figure 3 provides an example of the EOS form sent to the SCC for an hypothetical office. Figure 6 provides blank forms for the in-service requirements and the EOS report that may be reproduced locally.

### In-Service Requirement Calculation

**4.02** The following provides instructions for preparing the Minimum In-Service Requirement calculation forms.

**4.03** Figure 1 is an example of allocating the hours of the day by days of the week to the load categories A, B, and C.

- **Column A** - Enter the name of the traffic-sensitive component. The example studies MF transmitters.
- **Column B** - Enter the component BH CCS/MS or TK or CALL (C)/MS or TK, as applicable, from the most recent BHD study. This figure is obtainable from the component daily data. The component daily data report should be validated with unreliable data deleted. Study hour averages should be recalculated where appropriate. The example BHD data is shown in Fig. 4. The study averages shown in Fig. 4, Sheet 1 and 2 represent the nine

days of the study. Sheet 3 of Fig. 4 is a summary that can be used to evaluate the study for each component. See Section 231-070-558 for detailed descriptions of this output. The example busiest hour on the BHD is 15:30 to 16:30 with an average CCS/TK of .3180. Enter this figure in column B.

- **Column C** - Category A loads exceed maximum category B loads. Therefore, calculate the figure that represents maximum category B load by multiplying .85 by the entry in column B. In the example,  $.3180 \times .85 = .2703$ .
- **Column D** - From the BHD study, study average, determine those hours that have a higher CCS/MS or TK, or C/MS or TK, than the figure entered in column C. Enter these hours in column D. These hours represent category A hours since they are all above the maximum category B load. In the example, the BHD study average shows the category A hours to be 9:30 - 12:00 and 14:00 - 17:00. Enter these hours in column D. The days of the week included in the BHD study average will be shown for these hours. The days included in the example study are Monday, Tuesday, Wednesday, Thursday, and Friday. Enter these days as M through F (M-F) in column D.
- **Column E** - Category B loads exceed maximum category C loads. Therefore, calculate the figure that represents maximum category C load by multiplying .65 by the entry in column B. In the example  $.3180 \times .65 = .2099$ .
- **Column F** - From the BHD study, study average, determine those hours that have a higher CCS/MS or TK, or C/MS or TK than the figure entered in Column E but are equal to or less than the figure entered in column C. In the example the loads in those hours will be  $>.2099$  but  $\leq .2703$ . These hours represent load category B, since the load is less than category A but greater than category C. The days, again are those included in the BHD study average, M through F.
- **Column G** - In theory, category C hours and days would represent all days and hours other than those reported in categories A and B. However, certain switches may have materially

loaded hours on week-ends or hours not collected on the last BHD study.

**4.04** In the example, for instance, it would seem that hours earlier than 9:00 should have been collected since the hour beginning at 9:00 falls just short of a category A load. It is doubtful that this represents an immediate load buildup starting at 9:00. In lieu of more expansive data, it would be safe to judge that the hour 8:00 -9:00 would be at least a category B hour.

**4.05** In scanning the BHD output for MF transmitters, it can be seen that Mondays, 10-24-83 and 10-31-83, are consistently 8 to 10 percent higher than the reported study hour average. Although the Poisson theory takes into consideration reasonable day-to-day variations in the average BH traffic, the purpose of an in-service statement for maintenance release should consider consistent, measurable day-to-day variations (at least in the 10 percent or greater area).

**4.06** It can also be noted that Monday 9:00 - 10:00 and 13:30 - 14:30 are category A on the BHD study.

**4.07** Taking into consideration the conditions described in paragraphs 4.04, 4.05, and 4.06, notes should be made on the **Allocation of Hours** worksheet.

**4.08** Figure 2 is an example of the worksheet used to calculate the quantities of in-service equipment for load categories A, B, and C. This worksheet is completed as follows:

- **Column A - Component:** List the service-affecting items in this entity. The order of listing for each entity of the same type (1/1A, 2/2B or 3 ESS) should be consistent. The example component is MF transmitters.
- **Column B - Installed Circuits:** Enter the total quantity of circuits provided for this component. Include all circuits in the group, those provided for traffic as well as the number provided for service protection margin. Where there is more than one group of a given component, list each group separately. For instance, in a 1/1A ESS there may be as many as three separate groups of MF transmitters, one for the office pool, one for 90B CPS, and one for AMA service observing. The quantity of installed circuits may be obtained from the traffic engineer or a recent capacity determination loading study for the busy season for which this in-service requirement study is being made. A capacity determination loading study for MF transmitters for the example office is shown in Fig. 5. The quantity of circuits entered in column B is the circuits provided for service protection margin (2) plus the circuits provided for traffic (30), a total of 32 MF transmitters.
- **Column C -** Enter the highest expected component CCS/MS or TK or C/MS or TK, as applicable, for the study period. In the example, this figure may be obtained from column 10 of Fig. 5, .3300 CCS/TK.
- **Column D - Estimated Main Stations/Trunks:** Enter the highest estimated main stations/trunks for this study. Columns C and D should represent the same period of time. For the example, this quantity may be obtained from column 12 of Fig. 5, 1500 trunks.
- **Column E - Engineering Criterion:** Enter the engineering criterion and appropriate table as specified by the traffic engineer. This data is available from the capacity determination worksheets. The data in column C should reflect this engineering criterion (ABS, 10 HD or HD). In the example, Fig. 5, columns 4 and 5, show this to be ABS P.001.
- **Column F - Peak Factor:** - Enter the expected peak factor, HD/ABS or HD/10HD, as applicable. (If column E is ABS enter HD/ABS. If column E is 10HD enter HD/10HD. If column E is HD leave blank.) In the example, this entry may be obtained from column 8 of Fig. 5, 1.20.
- **Column G - Category A 100% BH Load:** Obtain this figure (CCS or C, as applicable) by multiplying column C by column D. In the example,  $.3300 \times 1500 = 495$ . Referring to the "Notes" on the Allocation of Hours worksheet, it can be seen that Mondays have been noted as being 10 percent higher than the ABS load. In column G multiply the normal category A load, 495 CCS, by 1.10 to obtain the Monday category A load, 545 CCS, and enter as shown.

- **Column H - Circuits Required:** Using the CCS or call load stated in column G, the engineering criterion table in column E and the peak factor (when applicable) in column F, enter the circuits required for category A. For a description of the use of the peak factor in determining circuits required, see Section 231-060-210 for 1/1A ESS, Section 232-060-210 for 2/2B ESS, and Section 233-060-210 for 3 ESS. In the example, read 495 CCS into the P.001 table. Note that the peak factor on the table at that point is 1.77, higher than the study peak factor of 1.20. Therefore, the number of circuits required, 27, may be read directly from this table. Read the Monday CCS, 545, into the P.001 table to obtain the in-service requirements for Monday, category A, 29 circuits.
- **Column I - 85% of BH CCS or Call Load:** This entry is obtained by multiplying column G by 0.85. In the example, this results in  $495 \times .85 = 421$ . Since there are no notes that Mondays vary notably in the category B area, no additional computations are necessary.
- **Column J - Circuits Required (category B):** Using the CCS or call load entered in column I, determine the circuits required for load/service category B in the same way described under column H. In the example, 421 CCS read into the P.001 table results in 25 circuits required in category B hours.
- **Column K - 65% of BH CCS or Call Load:** This entry is obtained by multiplying column G by 0.65. The example results in  $.65 \times 495 = 322$  CCS.
- **Column L - Circuits required (category C):** Using the CCS or call load entered in column K, determine the circuits required for load/service category C in the same way described under column H. In the example, this results in 20 circuits required in category C hours.

**4.09** The material gathered in the In-service Worksheet provides support for the maximum EOS statement sent to the maintenance forces. For practical purposes the EOS statement should cover broad bands of time covering as many days of the week as possible for each load category. At the same time, the categories should not be so broad that the

EOS statement is useless. As an example, all hours should not show an EOS equivalent to category A, or all hours show only the service protection margin quantity as maximum EOS.

**4.10** Since the statement of maximum EOS limits is an official directive to another department, the form used, as illustrated in Fig. 3, has a rather formalized heading. The heading of this form is as follows:

- **Wire Center** - Enter the wire center in which the studied entity is located.
- **Entity** - Enter the studied switching entity identifier.
- **Switch Type** - Enter 1, 1A, 2, 2B, or 3 ESS.
- **Busy Season** - Enter the months and years of the busy season which this EOS statement represents.
- **Telephone Number** - Enter the telephone number of the network administrator preparing this form.
- **Date Approved** - Enter the date that the Network Administration Center (NAC) manager and the network administrator approve the form.
- **Expiration Date** - Enter date the form will expire. The date may be one year from the approval date or the end of the engineering period, whichever is earlier.

**4.11** The body of the EOS form is completed as follows:

- **Column A** - Enter the name of the studied component(s). Enter in the same order as that used on the in-service requirement forms.
- **Column B** - Enter the total number of installed circuits from in-service requirement, circuits required, worksheet column B. The example value is 32.
- **Column C** - Enter the category A maximum permissible EOS for this component. This value is equal to the total installed circuits (32) minus the number of circuits required during category A hours (29). To simplify this statement in the example, the value 29

was selected for in-service requirements since this value would include demands on Mondays. The example results in  $32-29 = 3$  EOS for category A hours.

- **Column D** - Enter the hours for category A EOS values. In the example, again judgement is applied to simply state the hours for use of the maintenance forces. The hours selected in the example are 8:00 - 10:00 and 13:30 - 17:00, M-F. The morning hours starting at 8 instead of 9 were selected because of the unknown hour of 8:00 - 9:00. Since Mondays 9:00 - 10:00 are category A, it is safe to conclude that some part of the 8:00 -9:00 hour on Mondays may be category A. The hours 13:30 to 17:00 include the Monday category A hours.
- **Column E** - Enter the days of the week that correspond to the hours entered in column D for category A. As discussed under column D, these hours represent M-F.
- **Column F** - Enter the quantity of EOS circuits for category B. This value is obtained by subtracting the in-service category B requirements (25) from the total circuits equipped (32) ( $32-25 = 7$ ).

- **Column G** - Enter the hours in which category B load is expected for this study.
- **Column H** - Enter the days in which the hours reported in column G apply for category B load.
- **Column I** - Enter the quantity of EOS circuits for category C load. This value is obtained by subtracting the category C in-service requirements (20) from the total number of circuits equipped (32). In the example  $32 - 20 = 12$ .
- **Column J and K** - The category C hours and days represent all the hours in the days not shown at either category A or category B.

*Note* No differentiation is made in the statement of in-service requirements between components with engineering criterion ABS or HD/10HD. The proper criterion is used to establish the requirement for each component. The variation is ignored since the exact occurrence of a high day or ten high days is unpredictable. To this extent the statement of in-service requirements and EOS for HD/10HD engineered components is overstated and understated, respectively, for ABS.







NO.1 ESS 000392H ALPHA 1AEC5B65B.21 COMP. ID: 4

COMPONENT DAILY DATA

REPORT DATES: 10/24/83 - 11/04/83

REQUEST DATE: 11/22/83

MF TRANS P	MON 10/24/83	TUES 10/25/83	WED 10/26/83	THURS 10/27/83	MON 10/31/83	STUDY AVG	
09:00-10:00	0.2800✓	0.2614	0.2579	0.2488	0.2815✓	0.2617	B
09:30-10:30	0.3041	0.2869	0.2816	0.2663	0.2978	0.2800	
10:00-11:00	0.3159	0.3002	0.2916	0.2738	0.3061	0.2895	
10:30-11:30	0.3239	0.2981	0.2924	0.2776	0.3092	0.2920	A
11:00-12:00	0.3162	0.2745	0.2817	0.2716	0.2963	0.2812	
11:30-12:30	0.2579	0.2293	0.2275	0.2268	0.2463	0.2324	B
12:00-13:00	0.2083	0.1930	0.1774	0.1782	0.2030	0.1895	
12:30-13:30	0.2256	0.2119	0.2034	0.1961	0.2255	0.2086	
13:00-14:00	0.2618	0.2523	0.2445	0.2329	0.2606	0.2456	
13:30-14:30	0.2924✓	0.2756	0.2577	0.2540	0.2773✓	0.2672	B
14:00-15:00	0.3157	0.2906	0.2705	0.2751	0.2909	0.2813	
14:30-15:30	0.3303	0.2940	0.2787	0.2932	0.3110	0.2942	
15:00-16:00	0.3477	0.3164	0.2851	0.3094	0.3311	0.3110	A
15:30-16:30	0.3466	0.3312	0.2967	0.3192	0.3302	0.3180*	
16:00-17:00	0.3011	0.2941	0.2800	0.2916	0.2897	0.2879	
16:30-17:30	0.2258	0.2262	0.2209	0.2259	0.2180	0.2259	B
17:00-18:00	0.1753	0.1799	0.1767	0.1887	0.1742	0.1841	
17:30-18:30	0.1614	0.1712	0.1755	0.1766	0.1514	0.1708	
18:00-19:00	0.1593	0.1660	0.1763	0.1671	0.1354	0.1626	
18:30-19:30	0.1665	0.1720	0.1778	0.1707	0.1378	0.1649	
19:00-20:00	0.1687	0.1725	0.1762	0.1699	0.1366	0.1626	
19:30-20:30	0.1611	0.1598	0.1650	0.1545	0.1333	0.1486	
20:00-21:00	0.1533	0.1460	0.1500	0.1478	0.1268	0.1358	
20:30-21:30	0.1382	0.1222	0.1337	0.1396	0.1089	0.1183	
21:00-22:00	0.1097	0.0934	0.1108	0.1144	0.0865	0.0954	

\* BUSIEST HOUR  
✓ MONDAY CAT A

NOTES:

- \*\* THIS HOUR FAILED RELIABILITY TEST, AND WAS NOT INCLUDED IN STUDY.
- \*\* NUMBER OF RELIABLE DAYS DATA <= 50% OF TOTAL COLLECTION DAYS FOR THIS HOUR.

Fig. 4—Example of Busy Hour Determination Output (Sheet 1 of 3)

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## COMPONENT DAILY DATA

REPORT DATES: 10/24/83 - 11/04/83

REQUEST DATE: 11/22/83

MF TRANS P	TUES 11/01/83	WED 11/02/83	THURS 11/03/83	FRI 11/04/83	STUDY AVG	
09:00-10:00	0.2630	0.2540	0.2606	0.2480	0.2617	B
09:30-10:30	0.2672	0.2712	0.2798	0.2654	0.2800	
10:00-11:00	0.2806	0.2869	0.2802	0.2706	0.2895	
10:30-11:30	0.2846	0.2889	0.2694	0.2836	0.2920	A
11:00-12:00	0.2710	0.2744	0.2638	0.2812	0.2812	
11:30-12:30	0.2263	0.2325	0.2214	0.2234	0.2324	B
12:00-13:00	0.1866	0.1914	0.1871	0.1806	0.1895	
12:30-13:30	0.2006	0.2041	0.2077	0.2026	0.2086	
13:00-14:00	0.2394	0.2373	0.2423	0.2388	0.2456	B
13:30-14:30	0.2622	0.2622	0.2606	0.2627	0.2672	
14:00-15:00	0.2651	0.2772	0.2677	0.2786	0.2813	
14:30-15:30	0.2821	0.2850	0.2736	0.3000	0.2942	
15:00-16:00	0.3048	0.2969	0.2892	0.3190	0.3110	A
15:30-16:30	0.3149	0.3075	0.3021	0.3136	0.3180	
16:00-17:00	0.2940	0.2782	0.2765	0.2859	0.2879	
16:30-17:30	0.2330	0.2212	0.2260	0.2365	0.2259	B
17:00-18:00	0.1896	0.1850	0.1945	0.1929	0.1841	
17:30-18:30	0.1818	0.1702	0.1779	0.1712	0.1708	
18:00-19:00	0.1703	0.1643	0.1707	0.1538	0.1626	
18:30-19:30	0.1663	0.1661	0.1787	0.1479	0.1649	
19:00-20:00	0.1685	0.1630	0.1709	0.1367	0.1626	
19:30-20:30	0.1516	0.1440	0.1494	0.1187	0.1486	
20:00-21:00	0.1304	0.1274	0.1382	0.1022	0.1358	
20:30-21:30	0.1107	0.1081	0.1185	0.0847	0.1183	
21:00-22:00	0.0827	0.0899	0.0978	0.0737	0.0954	

## NOTES:

- \*\* THIS HOUR FAILED RELIABILITY TEST, AND WAS NOT INCLUDED IN STUDY.
- \*\* NUMBER OF RELIABLE DAYS DATA <= 50% OF TOTAL COLLECTION DAYS FOR THIS HOUR.

Fig. 4—Example of Busy Hour Determination Output (Sheet 2 of 3)

NO.1 ESS 000392H ALPHA 1AEC5B65B.21 COMP. ID: 4

BUSY HOUR SUMMARY (LONG FORM)

REPORT DATES: 10/24/83 - 11/04/83

REQUEST DATE: 11/30/83

< > ANGULAR BRACKETS INDICATE SUGGESTED COLLECTION HOUR PER COMPONENT.

SERVICE CIRCUITS:

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COMPONENT	NOTES	CBH CANDIDATE			AVG VALUE	RATIO		REL DATA	
		1	2	3		/CBH	/OBH	TOT	=BH
21. MF TRANS P	<16:30>				0.3180	1.00	1.00	9	6
			16:00		0.3110	0.98	0.98	9	3
				15:30	0.2942	0.93	0.93	9	0
22. DP TRANS P	<16:30>				0.3695	1.00	1.00	9	8
			16:00		0.3570	0.97	0.97	9	1
				17:00	0.3442	0.93	0.93	9	0
23. PWR RG-1 P	<16:30>				0.0298	1.00	1.00	9	8
			17:00		0.0291	0.98	0.98	9	1
				16:00	0.0285	0.96	0.96	9	0
24. PWR RG-2 P	<16:30>				0.0301	1.00	1.00	9	9
			17:00		0.0292	0.97	0.97	9	0
				16:00	0.0284	0.94	0.94	9	0
25. PWR RG-3 P	<16:30>				0.0310	1.00	1.00	9	9
			17:00		0.0300	0.97	0.97	9	0
				16:00	0.0294	0.95	0.95	9	0
26. AUD RG-1 P	<16:30>				0.0302	1.00	1.00	9	8
			17:00		0.0295	0.98	0.98	9	1
				16:00	0.0289	0.96	0.96	9	0
27. AUD RG-2 P	<16:30>				0.0306	1.00	1.00	9	9
			17:00		0.0297	0.97	0.97	9	0
				16:00	0.0288	0.94	0.94	9	0
28. AUD RG-3 P	<16:30>				0.0316	1.00	1.00	9	9
			17:00		0.0305	0.96	0.96	9	0
				16:00	0.0299	0.95	0.95	9	0

NOTES: SEE FOOTNOTES AT BOTTOM OF FIRST PAGE OF THIS REPORT.

Fig. 4—Example of Busy Hour Determination Output (Sheet 3 of 3)

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Office ALPHA  
Date 6-1-83 Busy Hr. 1500-1600  
Effective Period 1985 To 1984  
Reference Section 231-060-130  
Sheet 2 Of     

*LOADING PLAN*  
1/1A ESS SWITCH  
CAPACITY DETERMINATION (CD) WORKSHEETS

A. SERVICE CIRCUITS  
1.0 Capacity

SERVICE CIRCUIT (CPI)	CIRCUITS PROVIDED		CRIT	TBL	ENG. TBL PF	OCS CAP TFC SVC CHK	STUDY PERIOD					MS OR TRK CAP	% UTIL	
	SPH	TFC					STUDY PF	OCS CAP	OCS/MS OR TK C/MS OR TK	HT	MS OR TRK DEMAND			OCS DEMAND
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
<b>RECEIVERS</b>														
MF (065)			ABS (Note 1) 10HD (Note 2)	P.01										
RP (070)			ABS (Note 1) 10HD (Note 2)	P.01										
DP (068)			ABS (Note 1) 10HD (Note 2)	P.01										
TT/DP (029)			ABS (Note 4)	P.01										
<b>TRANSMITTERS</b>														
MF (066)	2	30	ABS (Note 1) HD (Note 2)	P.001 P.01	1.70 X	571	1.20 X	571	.3300	-	1500T	495	1730T	87
RP (071)			ABS (Note 1) HD (Note 2)	P.001 P.01	X X		X X							

Fig. 5—Example of Capacity Determination Worksheet





