

SWITCHING SYSTEMS MANAGEMENT
NO. 2 ELECTRONIC SWITCHING SYSTEM (2-WIRE)
LOAD BALANCE

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1. GENERAL

PURPOSE

1.01 The network administrator of *any* dial central office is responsible for ensuring that the maximum load is being carried and that the dial equipment is providing the best possible service to customers for the offered load. Good balance is required to achieve the maximum potential of the load-service relationship. The terminal equipment assignment policies established by the network administrator for loading an office will be reflected in the load balance of that office. (In the No. 2 Electronic Switching System [ESS], telephone numbers are not a loading consideration since they are a memory, or software, item.)

1.02 This section is reissued to include changes and procedures utilized in achieving good load balance. Major areas of change include: balance within a loading division, quality control limits (QCLs), and loading analysis. Information on the load balance index is deleted (see 1.04).

1.03 This section replaces all parts of the Central Office Management Guide, Division E, Section 4, as well as all other developed practices that describe line balance by class of service and line loading, including the development and interpretation of the score system and QCLs.

1.04 A load balance index (LBI) plan has been developed for No. 2 ESS and is discussed in Dial Facilities Management Practices, Division A, Section 5b, Load Balance Index Plan. This section describes the considerations necessary for measuring the load balancing of a No. 2 ESS.

1.05 While the same data are used for index and administrative purposes, the data for

index purposes are more stringent to ensure uniformity among all offices. Therefore, the data requirements and procedures for index purposes in Dial Facilities Management Practices, Division A, Section 5b, Load Balance Index Plan, will be followed. This section provides the statistical formulas for load balance calculations, QCL tables, and the calculation procedure for determining the percentage of engineered capacity, all of which are needed to produce the LBI. If the number of hours of study required in the index plan is not available for administrative purposes, factoring of the hours of data may be used. Factoring is discussed in 2.29.

NETWORK ADMINISTRATION RESPONSIBILITIES

1.06 The network administrator is responsible for good load balance and subsequent index reporting. In order to achieve the objectives of good load balance, this responsibility includes:

- (a) Loading plans
- (b) Busy-hour and adjacent side-hour determination
- (c) Scheduling of load balance and related studies
- (d) Data collection
- (e) Data validation
- (f) Load analysis and corrective action
- (g) Preparation of load balance forms (E-6615, E-6616, E-6617, and E-6402)
- (h) Reporting of load balance index results.

1.07 The title of each figure includes a number(s) in parentheses which identifies the paragraph(s) in which the figure is referenced.

2. PRINCIPLES OF LOAD BALANCE

GENERAL

2.01 Acceptable balance in a No. 2 ESS exists when the load generated by lines, trunks, and service circuits is distributed proportionately over the switches of the concentrators within the line trunk switching frames and the networks. Since perfect balance is virtually impossible because of the chance variation of customer-offered loads,

the network administrator is responsible for keeping the load within practical limits. These are QCLs which have been developed for No. 2 ESS.

2.02 Balancing an office maintains service to the customer by reducing the possibility of switching failures (eg, no dial tone, matching loss, and overflow in junctors or trunks). Balance reduces subsequent customer attempts if the overflows (no circuit or reorder) are kept to a minimum. Sound balance is also important in an underloaded office. It is difficult, time-consuming, and expensive to rebalance an office once it has been permitted to become imbalanced.

DEFINITION OF TERMS

2.03 The terminology and definition of terms used in this section are discussed in Dial Facilities Management Practices, Division A, Section 5b, Load Balance Index Plan.

LOAD UNIT CONFIGURATION

2.04 Unlike most dial systems, the No. 2 ESS is comprised of a "folded" network wherein lines, trunks, and service circuits are terminated on office equipment numbers (OENs, formerly called terminal equipment numbers [TENs]) in the concentrators of the line trunk switching frame. The usage measurements taken on the B-links for each concentrator (2:1 type) or a pair of concentrators (4:1 type) on network 00 through network 14 and printed in the W-schedule are considered the load unit and will be used as a basis for load balance. ***The B-link usage in a 4:1 type network is accumulated for two concentrator groups as defined in Dial Facilities Management Practices, Division H, Section 10b, System Description, and cannot be separated.*** The usage on the B-links includes usage generated by lines, trunks, and service circuits terminated within the concentrators.

BALANCE WITHIN A LOADING DIVISION

2.05 The QCL tables are based upon a B-link group capacity of 230 CCS for a 2:1 type network and a paired concentrator B-link group in a 4:1 type network (Fig. 1). For an unpaired concentrator B-link group in a 4:1 type network the group capacity is 115 CCS (Fig. 2). The unpaired B-links will generally occur in fractional 4:1 type line trunk networks (LTNs). See Dial

Facilities Management Practices (DFMP) Division H, Section 10b, System Description for more details. Wherever 4:1 type networks with paired and unpaired concentrator B-links are employed, separate loading divisions are required for index purposes as discussed in DFMP, Division A, Section 5b.

2.06 A given office may be arranged for 2:1 or 4:1 type full and/or fractional networks with B-links arranged for either traditional services (ie, lines, trunks, and service circuits); range-extension lines, trunks, and service circuits; or both.

2.07 Concentrators connected by B-links arranged for range extension can serve **only** range-extension lines. All concentrators, range-extension and nonrange-extension, can have trunks and service circuits assigned. Range extenders are normally equipped to serve range-extension lines throughout the growth period. Often the requirement for these lines is less than the number required at the end of the engineering period. Since the concentrators cannot be assigned nonrange-extension lines, it is suggested that the B-links be redefined (paired or unpaired concentrators) for regular service and that concentrators be assigned with regular lines until the requirement for range-extension lines necessitates that the concentrators be returned. This procedure will help to maintain concentrator load balance. It is possible for one of the concentrators of a pair which is served by B-link range extenders to be defined as nonrange-extension. This procedure is **not** recommended since both concentrators are measured by the common set of B-links and it is difficult to identify which of the two is contributing to the load. When the concentrators, which are range extension but which have been defined as nonrange-extension, are assigned regular lines and more range-extension lines are needed, it will be necessary to reassign those regular lines to other nonrange-extension concentrators before redefining the concentrators for range extension.

2.08 If there are switching network growth additions, the newly equipped B-link groups may be considered as a separate loading division as defined in Dial Facilities Management Practices, Division A, Section 5b, Load Balance Index Plan.

2.09 The end of engineering period (EOP) network CCS is the criterion by which the No. 2 ESS network and junctors are engineered. This CCS value divided by the number of B-link groups is

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the recommended maximum load which each B-link group may carry.

2.10 As described in 2.05, CCS values for **Load Balance purposes** are defined as 115 CCS and 230 CCS depending upon the type network installed.

2.11 Load balance is predicated upon these loads (TL) as compared to the actual measured carried loads (AL) expressed as a percentage and as described beginning in 2.21.

2.12 The design (traffic) engineer designs the particular No. 2 ESS within the concept of equal distribution of load and maintaining objective service levels. The network administrator is responsible for distributing the load if the inherent call-carrying capacity of the office is to be achieved. Because the OENs are assigned items of equipment with varying attempt and holding-time values, acceptable balance becomes more critical as engineered capacities are reached. The considerations, techniques, and procedures used in achieving good load balance are discussed in Part 3.

IMBALANCE INDICATORS

2.13 In addition to the B-link usage, other service-level indicators which may be indicative of busy-hour imbalance are as follows:

(a) Network Switching Performance Measurement Plan (Dial Line Index Plan).

(b) The No. 2 ESS traffic measurements as discussed in Bell System Practices Section 232-120-301 are organized into a series of schedules. The Q-schedule (quarter-hour readings) shows dial-tone delays and matching losses. The Q-schedule measurements will also print on the network (traffic) teletypewriter whenever one of the following conditions exist.

- (1) The number of dial-tone-speed tests during the last quarter-hour was not equal to 225.
- (2) The number of dial-tone-speed-test failures in the last quarter-hour exceeded four.
- (3) The system is in dynamic service protection or indicates that it should be implementing dynamic service protection.

(4) The system was in a system-overload condition at the clock quarter-hour.

(c) The H-schedule shows dial tone delays, matching losses, service-circuit usage, maintenance-busy and overflow counts, PBX overflow counts, individual customer overflow counts, and junctor usage which can be compared to the B-link usage for each network (junctor usage times two equals B-link CCS). The H-schedule may be scheduled in the load balance busy hour.

(d) The C-schedule shows trunk group usage, maintenance-busy, and overflow counts. If necessary, the C-schedule can be printed in the load balance busy hour.

(e) The repair center may also furnish busy hour no-dial-tone/no-trouble-found reports daily. (These reports may be indicative of trouble conditions in the office.)

(f) Load service measurements print when a transient clear initialization occurs or upon a teletypewriter input request. Refer to Dial Facilities Management Practices, Division H, Section 10i, Network Administration Measurements, for additional information on load service measurements.

2.14 An office which is experiencing poor service, as measured by the Network Switching Performance Measurement Plan, requires analysis to determine the extent to which balancing is contributing to the problem. For example, poor dial-tone-speed results may be caused by poor balance, overload, equipment outage, or a combination of all three.

2.15 Out of busy season and in other periods of light loading, the service indicators may not be adequate to signal the need for corrective action. It will therefore be necessary to review the load balance data and determine if any transfers are necessary to prevent poor service during the busy season when heavier loads will occur.

DETERMINATION OF BUSY HOUR AND ADJACENT SIDE HOUR

2.16 The B-link usage busy hour must be the time-consistent hour of highest total usage (CCS) generated by the lines, trunks, and service

circuits in the busy season. This hour is determined by a study of the junctor usage as discussed in Dial Facilities Management Practices, Division H, Section 10i, Network Administration Measurements. The side hour is determined as discussed in Dial Facilities Management Practices, Division A, Section 5b, Load Balance Index Plan.

2.17 In offices with two distinct hours which are nearly equal in usage and which are nonadjacent, it may be necessary to study both periods if service is poor in the hour of lesser usage. Special attention to the assignment procedures is required to ensure that those groups which are below average in each hour are assigned an equal proportion of the various classes of service. These two nonadjacent hours **cannot** be combined into a study period.

2.18 Load balance usage data should be collected as frequently as required to ensure good balance with a minimum of 10 hours per month. The 10-hour minimum is imposed by the load balance index requirement. As the office approaches capacity, more frequent studies are needed to ensure the most efficient balance of office load.

QUALITY CONTROL LIMITS

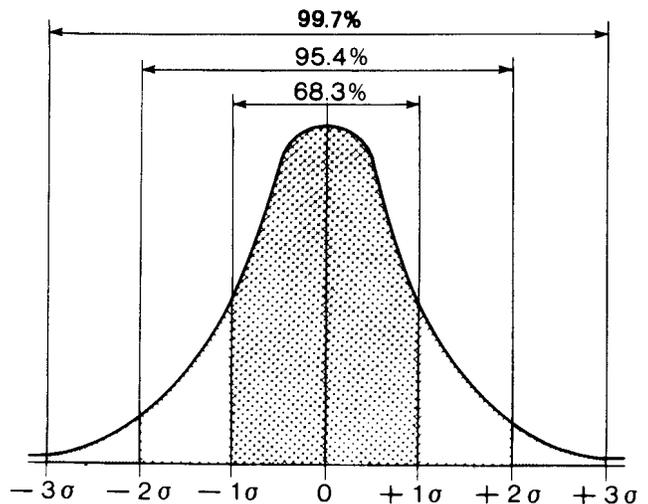
2.19 The quality control technique is a practical way of taking advantage of mathematics in order to create a uniform approach to load balance procedures. This technique reliably indicates whether fluctuations in load data might be the result of chance or the result of differences in office performance and, consequently, indicates whether corrective action should be taken. A successful quality control plan requires limits to be used that will satisfactorily and accurately indicate a true imbalance.

2.20 **Chance** and **imbalance** are two primary causes for variation of individual load-unit usage from the average of a number of groups in the same division. Chance variations result from the random calling patterns of customers using their telephones. The size of chance variations depends upon certain measurable office characteristics:

- (1) Average holding time of calls
- (2) Percentage of loading of the division
- (3) Number of customers, trunk, and service circuits.

The general rule is that the larger the sample measured, the smaller the chance variation relative to the size of the sample. Each of the characteristics mentioned above affects the size of samples observed in load studies.

2.21 It can be demonstrated that group variations due to chance, in a reasonably balanced loading division, follow the normal distribution pattern which is a "bell-shaped" distribution around the mean (average). This normal distribution can be described by stipulating a mean value and the measure of dispersion of group loads around that value. The measure of dispersion, adjusted for the number of hours of data, is commonly called the standard deviation (SD or σ). Office trends are not a factor since each group is related to the average of all groups. An area representing one standard deviation from the mean in a normal distribution may be expected to include 68.3 percent of all the group measurements. Two standard deviations will be 95.4 percent of all measurements, and three standard deviations will be 99.7 percent of all measurements. This is illustrated in the following distribution curve where the symbol σ (sigma) represents a standard deviation and the symbol \bar{x} represents the mean.



2.22 The problem of isolating and evaluating chance variation may be resolved by utilizing procedures involving the standard deviation. By using such procedures the size of a deviation from

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the mean may be used to judge whether that deviation may be due to chance or whether it is most probably due to imbalance. As a basis for this judgment, standard QCLs representing three standard deviations have been developed. As an example, consider 1000 groups for which the measured loads are averaged. The mathematical analysis indicates that only 0.3 percent (the 0.3 percent outside the 99.7 percent) of those measurements may be expected to differ by chance from the mean by more than three standard deviations (ie, the QCL). In effect, it can be assumed that all deviations from the mean greater than the QCL are due to imbalance. Choosing a larger QCL increases this assurance; however, there is a greater chance that some deviations which truly reflect imbalance will be ignored. These three standard deviation (3 sigma) limits are shown in the QCL charts in Figure 1 and Figure 2.

2.23 The first step in determining which QCL to use is to calculate the percentage of capacity for the study period. This is accomplished by taking the actual average load (AL) and comparing it to the TL. The QCL value derived from this computation makes allowance for the fact that group loads in a lightly loaded office can fluctuate more than those in a comparable heavily loaded office.

2.24 This computation is done by dividing the total actual average usage (in CCS) per load unit by the TL (in CCS) per load unit and multiplying the result by 100. The answer obtained is the percentage of capacity at which the groups are operating for the given study period. This computation is done for each loading division. This percentage is then used to determine the table from which the QCL will be selected for that loading division. There are eight columns which cover loading ranges from 30 percent to over 96 percent (Fig. 1 and Fig. 2).

2.25 Assume that a 4:1 type office has two loading divisions: one loading division has 6 networks of paired B-links (192 B-link groups) and one loading division has a growth of one-half network of unpaired B-links (32 B-link groups).

The calculation of the percentage of B-link group load to TL for the study period for each loading division is as follows:

Step 1:

Divide total network CCS by whole and fractional LTNs to obtain designed capacity.

For example:

$$\text{LTN (designed) capacity} = 7360 \text{ CCS}$$

$$7360 \text{ CCS} \div 32 \text{ B-link groups per LTN} = 230 \text{ CCS}$$

$$\text{TL for 2:1 type and 4:1 type paired B-links (TL)} = 230 \text{ CCS}$$

$$\text{TL for 4:1 type unpaired B-links (TL)} = 115 \text{ CCS}$$

Step 2:

Average load (AL) of the initial or pregrowth loading division.

$$\begin{aligned} &192 \text{ paired B-link groups} \\ &\text{B-link usage (average busy hour)} = \frac{\text{B-link usage}}{\text{Number of hours}} \end{aligned}$$

$$\div \text{total paired B-link groups}$$

$$= \frac{259,200}{10} \div 192$$

$$= 25,920 \div 192$$

$$\text{AL} = 135$$

Step 3:

$$\begin{aligned}
 \text{Percentage of TL B-link group} &= \frac{AL}{TL} \times 100 \\
 &= \frac{135}{230} \times 100 \\
 &= 0.5869 \times 100 \\
 &= 58.7\% \\
 &= 59\%
 \end{aligned}$$

Step 5:

$$\begin{aligned}
 \text{Percentage of TL B-link group} &= \frac{AL}{TL} \times 100 \\
 &= \frac{62}{115} \times 100 \\
 &= 0.5391 \times 100 \\
 &= 53.9\% \\
 &= 54\%
 \end{aligned}$$

Step 4:

AL of the growth addition loading division 32 unpaired B-link groups

$$\begin{aligned}
 \text{B-link usage} &= 19,900 \\
 \text{B-Link AL} &= \frac{\text{B-link usage}}{\text{Number of hours}} \div \text{Total unpaired B-link groups} \\
 \text{B-Link AL} &= \frac{19,900}{10} \div 32 \\
 &= 1990 \div 32 \\
 &= 62.18 \\
 &= 62
 \end{aligned}$$

2.26 QCL tables also require the use of average holding times (AHTs) of the calls creating usage on the terminal equipment. It is necessary to document the average holding time in a traffic unit for each balance study in order to obtain the most accurate results. Computations of average holding time in seconds are done as follows:

$$\text{AHT} = \frac{\text{Total B-link usage (SBH)} \times 100}{2 (\text{Total originating calls [OFT 06]} + \text{Total incoming call attempts [OFT 08]} + \text{Tandem call attempts for the session busy hour (SBH) [OFT 17]})}$$

Note: The average holding time can only be calculated for the total office and not for separate loading divisions.

2.27 Where it is *impossible* or *uneconomical* to implement this procedure, one of the following methods (listed preferentially) may be used.

- (1) Use an average holding time for the busy hour (BH) of the balance study week. (Program for Administrative Traffic Reports On-Line [PATROL] or junctor usage times 100 divided by two times the total of originating calls [OFT 06] plus total of incoming call attempts [OFT 08] plus tandem call attempts [OFT 17]).
- (2) Use an average holding time for a session busy hour in the most recent available week.

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- (3) Use an average holding time for the busy hour in the most recent available week.

2.28 After the average holding time and percentage of capacity are calculated, the QCL percentage is determined as follows.

- (a) Using the first example for paired B-link groups in 2.25, select QCL table in Figure 1.
- (b) Assume that the average holding time is 231 seconds.
- (c) Under column "Average Holding Time (Secs)," find the line designated 231–250.
- (d) Go across the line to column 4 (56%–65%) which is the percentage of B-link group engineered load.
- (e) Read the QCL percentage which is 27.
- (f) Using the second example for unpaired B-link groups in 2.25, select QCL table in Figure 2.
- (g) Assume that the average holding time is 231 seconds.
- (h) Under column "Average Holding Time (Secs)", find the line designated 231–250.
- (i) Go across line to column 3 (46%–55%).
- (j) Read the QCL percentage which is 42.

2.29 The QCL tables in Figure 1 and Figure 2 were constructed using 10 hours of data for a base. These tables are the only Bell System tables allowed for computing the load balance index as described in Dial Facilities Management Practices, Division A, Section 5b, Load Balance Index Plan. It is recommended that 10 hours of data be obtained for all load balance procedures whenever possible. In those cases where this is not possible, an adjustment for the number of hours for administrative load balance studies may be made. This adjustment corrects the QCL for the lesser reliability of smaller sessions and is calculated as follows:

$$Q = \sqrt{10/N} \times \text{table QCL value}$$

Where:

Q = The new QCL

N = The number of hours of the study

The value of the square root may be determined from the following table. This answer can then be multiplied by the table QCL value (Fig. 1 and Fig. 2) to determine Q. (*This procedure may not be applied to load balance index studies.*)

N	5	6	7	8	9	10
$\sqrt{\frac{10}{N}}$	1.41	1.29	1.20	1.12	1.05	1.00

Example:

Given:

Table QCL value = 30%

$$\begin{aligned}
 Q &= \sqrt{\frac{10}{8}} \times 30\% \\
 &= 1.12 \times 30\% \\
 &= 33.6\% \\
 &= 34\%
 \end{aligned}$$

2.30 After computing the QCL as described in 2.17 through 2.27, it is possible to establish CCS values for the ± 3 sigma points. It is also necessary to indicate load units that are approaching these limits. The CCS values are established by designating intermediate points at ± 1.5 sigma. For example, assume that average usage per load

unit in a loading division is 200 CCS and the QCL is 44 percent.

$$200 \text{ CCS} \times 0.44 = 88 \text{ CCS}$$

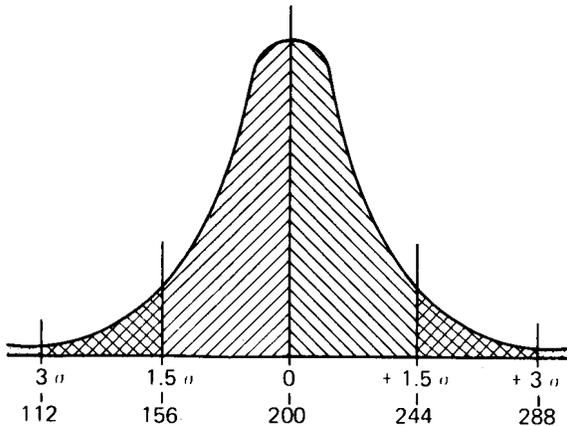
$$+3.0 \text{ SD} = 200 \text{ CCS} + 88 \text{ CCS} = 288 \text{ CCS}$$

$$-3.0 \text{ SD} = 200 \text{ CCS} - 88 \text{ CCS} = 112 \text{ CCS}$$

$$+1.5 \text{ SD} = 200 \text{ CCS} + 44 \text{ CCS} = 244 \text{ CCS}$$

$$-1.5 \text{ SD} = 200 \text{ CCS} - 44 \text{ CCS} = 156 \text{ CCS}$$

This is illustrated in the distribution curve which follows.



2.31 The use of CCS values at the specified 3 and 1.5 sigma limits works well for one week's data. Unfortunately, when a history is maintained to increase statistical reliability, the calculations become too complicated to utilize on a manual basis. This deficiency is overcome by using an alternate method called the score system.

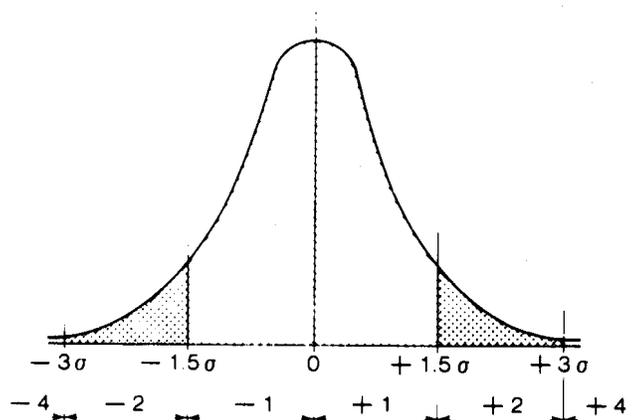
DEVELOPMENT OF SCORES

2.32 The score system has been developed to simplify the calculations required in the balancing of load units. The system substitutes a very simple number for a much larger number to enable subtractions and additions to be made quickly

and simply. Numerical values are assigned to represent the extent to which each load unit has departed from the group average during a measurement period. In application, all groups exceeding the QCL on a weekly record are assumed to be out of balance. The other groups, however, also deviate to a lesser degree above and below the average.

2.33 The procedure for deriving scores is to take the QCL percentage as determined in 2.21 through 2.31 and applying it as follows:

- (a) Each load unit with exactly average CCS is assigned a score of 0.
- (b) Each load unit deviating above or below average to a maximum of 1.5 standard deviations, half the QCL, is assigned a score of +1 or -1.
- (c) Each load unit deviating above or below 1.5 standard deviations from the average to a maximum of 3.0 standard deviations is assigned a score of +2 or -2.
- (d) Each load unit deviating above or below 3.0 standard deviations from the average is assigned a score of +4 or -4. Note that 4 is used rather than 3 in order to accentuate this undesirable deviation (see the distribution curve which follows).



3. SWITCHING SYSTEM BALANCE CONSIDERATIONS

GENERAL

3.01 When a No. 2 ESS is initially loaded with lines, trunks, and service circuits care must be exercised in assigning them to the switches of a concentrator and to concentrators and LTNs in order to obtain as good an initial balance as possible.

LOADING RESTRICTIONS AND FEATURES

3.02 Essential lines, ground start lines, certain test lines, trunks, and service circuits must be assigned on predetermined levels of the switches in the concentrators. These and other restrictions are discussed in the No. 2 ESS Translation Guide (TG-2H), Division 4, Preparation of Forms.

3.03 Another major consideration is whether the main frame is a conventional or modular combined distributing frame. Subscriber cable, especially centrex customer cable, must be spread over all zones to preclude longer cross-connections or assignments in a limited number of concentrators. The network administrator and the central office maintenance personnel may make changes to shorten the jumpers using the assignment guidelines provided in Dial Facilities Management Practices, Division H, Section 10o, Assignment Administration. The dispersion of various trunk groups and service circuits over the main frame must also be considered for distribution on the main frame.

3.04 The preferential network assignment list (PNAL) is the tool recommended for use in the distribution of various customer lines, outgoing trunks, incoming trunks, and service circuits for **initial loading of the office.** (*The preferential network assignment list is not recommended for use when the office is in an operating mode.*) Trunks (especially high-usage trunks) will have longer holding times while an equivalently loaded OEN may have a service circuit where the load is imposed by a high call volume and a low holding time. Customer lines, in the No. 2 ESS, as in other dial systems, possess their own characteristics (eg, coin, flat rate, centrex, outward wide area telephone service (WATS), inward WATS, PBX, party, measured, custom calling features, etc). Before translations are approved for office data administration (ODA) system processing, it is recommended that the following rules be observed.

(a) No more than one trunk or service circuit should be assigned to a switch until all switches in the network have been assigned at least one trunk or service circuit.

(b) An estimated balance of high- and low-usage trunks and service circuits should be assigned to all concentrators and switches within a concentrator.

(c) Customer lines may be spread by class of service as equitably as possible in each of the B-link groups. This is discussed in Dial Facilities Management Practices, Division H, Section 10o, Assignment Administration.

(d) Coin lines may be assigned as residence or business, depending upon expected usage.

(e) Custom calling features which use 3-port or 6-port conference circuits require more than one link when the feature is used; therefore, discrimination should be exercised in making these assignments.

3.05 Once the No. 2 ESS is in an operating mode and has stabilized, it is recommended that the network administrator take immediate CCS studies of trunks and service circuits, as discussed in 2.13, in order to assess the B-link usage of the concentrators. By assigning CCS values to individual trunks and service circuits (H- or C-schedule trunk group CCS divided by the number of members in the group) **in the load balance busy hour**, changes may be required to give better trunk and service-circuit balance within the concentrators. (Incoming trunk usage can usually be obtained from the originating office.)

LOADING PLANS

3.06 Continued practical balance of the office may be maintained with the assignment of customer lines via service orders and/or through attrition of discontinued customer lines. Therefore, the network administrator should develop a plan which will work toward this objective. The loading plan should be designed to improve balance at each opportunity and to ensure optimum balance during periods of peak loads. This plan should reflect the needs of the current busy season as well as those of the future when engineered capacities will be reached or exceeded and load balance becomes critical. Increased attention is required to ensure

that service goals are met in this situation. A more detailed explanation of load plans and assignment procedures for initial and continuing assignment is described in Dial Facilities Management Practices, Division H, Section 10o, Assignment Administration.

LOAD ANALYSIS

3.07 Customer-offered loads vary from day to day and from week to week. The effect on trunks and service circuits varies proportionately. Constant analysis of these changes in concentrator loads is required to determine the effect on service.

3.08 As is true in other dial systems, each No. 2 ESS will have unique characteristics. The number of high- and low-usage lines (centrex, data ports, WATS, business, coin, residence, etc), trunks (outgoing, incoming, and tandem), and service circuits may differ markedly from one system to another. The busy hour usage usually reflects the type of customer which imposes this usage. If this hour is an evening busy hour, the residence customer generates the highest load. Conversely, if this hour is a morning busy hour, the business customer, with some residential traffic, generates the highest load. An afternoon busy hour is normally a combination of business and residential traffic. Some business lines such as computer ports and WATS lines contribute heavy usage in all hours because the customer's business dictates this kind of usage. Coin traffic may not always contribute heavy usage during the usage busy hour; however, coin traffic may have its own class-of-service busy hour.

3.09 A comparison between the average load of the paired B-link groups and the average load of the unpaired B-link groups can be made to determine if more load should be imposed in one group or the other. (In the example shown in 2.25, 135 CCS versus 62 CCS would indicate that more load should be added to the unpaired B-link groups.)

3.10 In the W-schedule, in which the B-link usage for each B-link group is recorded, 64 registers are also available to make studies of individual customer line usage. These lines can be programmed in the machine through input messages as shown in the input manual (IM-2H200). Therefore, 64 lines of all classes of service (not multiline hunt lines) or 64 lines of one class of service (not multiline hunt lines) may be studied in the busy

hour. It is recommended that studies be made of lines by class of service in the busy season in order to assign a CCS value to that class. There will be exceptions; for example, computer ports which may be assigned as business lines. These should be studied separately.

3.11 If the B-link groups continue above (+4) or below (-4) average or are in the hotspot load threshold range of 346 CCS, corrective action is required. (Refer to Dial Facilities Management Practices, Division A, Section 5b, Load Balance Index Plan, for an explanation of hotspot load threshold range.) When the network administrator determines that corrective action is required, customer lines should be moved if the trunks and service circuits have been balanced as discussed in 3.05. Guidelines for moving CCS values are outlined in Part 5.

3.12 Once corrective action has been initiated, the transfer list should be sent immediately through proper channels to make the transfer. The time frame in which the transfers are completed should be minimal, preferably within a week. If the transfer list is outstanding beyond a week, the network administrator must follow up and request that the transfers be completed. Transfers may be kept to a minimum unless serious imbalance exists and the condition *cannot* be corrected with line assignments.

3.13 In manually assigned offices, the network administrator must always review the outstanding OENs advanced to the plant assigner; if these OENs no longer contribute to balance requirements, they should be recovered.

3.14 If cable pairs (cable throws) are transferred in great numbers, they tend to create an exorbitant number of long cross-connections on the main frame (see 3.03).

3.15 Should the characteristics of an office change as a result of the addition of customers through area cuts (centrex customers, new classes of service, etc) a new usage busy hour study should be scheduled to verify the busy hour and adjacent side hour.

CLERICAL TRAINING

3.16 The clerical forces must be trained to summarize and use the load balance data

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for best assignment advantage and to take corrective action.

MAIN DISTRIBUTING FRAMES

3.17 The following types of main frames can be used with the No. 2 ESS:

- (a) An ESS modular distributing frame
- (b) The standard or conventional main frame.

3.18 The ESS modular distributing frame is used to interconnect the trunk, service circuit, and subscriber line cable with OENs of the concentrators on verticals of a single-sided frame. A modular distributing frame module consists of ten vertical files. The cable and terminal equipment verticals are interspersed to reduce cross-connect jumper length. Space is provided between verticals to store the jumpers. With proper assignment, long jumpers which are stored in the upper or lower jumper wire troughs may be kept to a minimum.

3.19 The standard main frame has protector, connector, or jack mountings on one side (vertical side) of the main frame and terminal blocks on the other side (horizontal side) of the frame. The trunk, service circuit, and subscriber line cable are terminated on blocks on the vertical side of the frame and the OENs (concentrators) are terminated on blocks on the horizontal side of the frame. The frame may be sectorized (zoned) for administrative purposes, so that short jumpers are used between the vertical side and the horizontal side of the frame.

3.20 A specially designed combined distributing frame for the modularized installation (No. 2A ESS) comes equipped with junctor grouping jacks and plugs, terminal strips, and cable connectors. No other frame may be used in this type of installation since the units in the No. 2A ESS are prefabricated to be shipped to and placed at the telephone site.

3.21 Main frame assignment is discussed in detail in Dial Facilities Management Practices, Division H, Section 10o, Assignment Administration.

4. DATA COLLECTION

DATA ACQUISITION

4.01 Load balance data are collected on the weekly measurement schedule which is also known as the W-schedule. The W-schedule can be varied to collect and print any number of hours per day for any number of days per week. The load balance data are collected on a maximum of 32 B-link groups per network. The measurement of B-links for each concentrator in a 2:1 type network or a pair of concentrators in a 4:1 type network includes B-links made busy for maintenance purposes and reserved B-link usage. The printout appears in ascending order of networks and B-link groups within each network.

4.02 To obtain a load balance tape and printout, the W-schedule must be programmed using form ESS 2400, Traffic Work Table Assignment, as discussed in TG-2H, Division 4, Preparation of Forms, and Dial Facilities Management Practices, Division H, Section 10d(8), Operational Features, Teletypewriters. The W-schedule and other measurement schedules are discussed in Dial Facilities Management Practices, Division H, Section 10i, Network Administration Measurements, and the No. 2 ESS Translation Guide, Division 10, Traffic Measurements.

DATA COLLECTION FREQUENCY

4.03 Data must be collected and reported once per month for index purposes. Data should also be collected frequently for the following administrative reasons.

- (a) The office is out of balance and the network administrator wants to analyze the results of specific corrective action procedures.
- (b) The office is nearing the end of the job interval and/or is load limited; therefore, fine-tuned assignments are required to ensure objective service levels.
- (c) The office is a new installation (at or greater than 30 percent of capacity) or a growth addition has just been completed; therefore, a new load balance data base is required. The quicker the data are collected, the sooner the balance may be analyzed.

(d) The office has just completed an area cut and the network administrator wants to evaluate the effects of the applied loading techniques.

MISSING OR INCOMPLETE DATA

4.04 The load balance data are scheduled to print at the end of a study period, but it may be worthwhile to check the data periodically during the study period to ensure that data are available and reliable.

4.05 There may be times when the data for the study week are incomplete as a result of loss of call store data, mutilated printouts, etc. The criterion for data reporting (in compliance with Dial Facilities Management Practices, Division A, Section 5b, Load Balance Index Plan) is that a minimum of 7.1 hours is required but that the full complement of 10 hours is preferred. Therefore, if 6 hours of data are available, they can be approached in several ways as follows.

- (a) If available, 4 hours with the same traffic characteristics may be used from the previous collected week within the study month.
- (b) The entire 10 hours from the previous study may be used, if available.
- (c) As few as 2 hours with the same traffic characteristics from the previously collected study may be used to create an 8-hour study which will be treated as a 10-hour study for scoring purposes. However, every effort should be made to acquire the necessary quantity of data.

If valid data cannot be obtained within the study month, for index purposes the data are considered not available. For administrative purposes, the procedure outlined in 2.29 is followed.

DATA VALIDATION

4.06 The network administrator is responsible for the validation of load balance measurements. There are several methods of validating load balance data. These involve visual inspection and other methods to determine if the measurements are reasonable.

(a) A visual check can be made to ensure that there are no zero register readings.

(b) Readings which exceed 16 B-links times 36 CCS times the number of data hours are invalid.

(c) Compare actual B-link usage with the TL of the B-links as outlined in 2.25. Thus, measurements which are at or exceed capacity should be evaluated on the basis of whether they reflect valid data and/or a load balance problem. The percentage of capacity is relative to the expected load. Service-affecting items would be expected infrequently (if the office is balanced) in an office at 50 percent of capacity and more frequently as the percentage of capacity is approaching TL.

(d) Total junctor usage times two equals B-link usage.

5. BALANCE TECHNIQUES

MANUAL PROCEDURES

5.01 In the No. 2 ESS, unlike the No. 1 ESS, no interim mechanized system employing PATROL is contemplated. However, a Load Balance System (LBS) will be an integral part of the downstream process employed by the Total Network Data System (TNDS).

5.02 As explained in this section, load balance techniques may contribute to better utilization of the No. 2 ESS facilities while avoiding service irregularities. As offices approach 50 percent of their design capacity, load balance activity ensures satisfactory levels of service and precludes isolated imbalances which may cause customer dissatisfaction.

5.03 Manual calculation of load balance indexes and the normal processing of load-balance data are discussed in 5.04 through 5.19. These processes will be incorporated into the mechanized programs.

5.04 Two forms are available for use in manual processing of load balance data. Form E-6615, Load Balance Score Control Record, is used for developing the weekly CCS ranges for the loading division. Form E-6616, Load Unit—Load Balance Chart, is used to record the B-link load unit weekly scores, penalty points, and hotspot

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penalty points. Figures 3 and 4 show examples of the required forms and instructions for completion.

CORRECTIVE ACTION

5.05 Corrective action is taken when there are adverse service indications or the load measurements point to areas where there are high probabilities of blockage which is a possible source of customer dissatisfaction.

5.06 The proper corrective action must be established in the following sequence to be most meaningful.

- (1) Review all load balance data. They will indicate load units that are working at exceptionally heavy or light loads.
- (2) Review raw data on the load units highlighted in (1). This review may prove to be the most valuable step of the procedure. Errors at this stage cause unnecessary or incorrect action.

Note: Links made busy should be investigated when verifying data. This may be done by requesting from network maintenance a peripheral unit status printout during a corresponding session busy hour.

- (3) Assuming that the data are valid, review the required CCS corrective action.
- (4) If time and service conditions permit, balance should be achieved by directed assignments.
- (5) If OEN transfers are required, several indicators (such as dial tone delay and matching losses) should be analyzed to determine the proper lines to move.

5.07 The most economical method for achieving and maintaining a good load balance is through routine line assignment procedures (directed line assignments). A network administrator simply assigns new connects to lightly loaded units and allows disconnects to accumulate in heavily loaded units. Disconnects of lines in heavily loaded units equalize the carried CCS among groups. On the other hand, disconnects in lightly loaded concentrators heighten the imbalance.

5.08 OEN transfers can accomplish the same result as directed line assignments. This corrective action produces quicker results. However,

OEN transfers are expensive to implement and, therefore, should be the last-choice method of corrective action.

5.09 A remedial action computation method should have the following features.

- (a) It should be based on empirical CCS measurements rather than scores. Differences in loads, even among groups with the same scores, could then be detected.
- (b) It should be sensitive to usage trends to avoid future overloads.
- (c) It should apply more weight to recent measurements since they are more representative of the actual load situation.
- (d) Finally, it should correct the usage in load units to the average for the loading division to avoid wasteful overcorrection.

5.10 In manual data processing environments, it is uneconomical to expend clerical time to achieve all four of the features mentioned in 5.09. The approach shown in 5.11 through 5.19 is a compromise for manually processed data.

5.11 For clerical ease, the proposed plan uses weekly scores rather than actual CCS values. The plan uses recent data rather than older data and attempts to correct group loads to average usage without overcorrecting.

5.12 This procedure is based upon computing an estimate of the average weekly score for each load unit, determining a factor, and calculating the CCS correction as follows:

$$\frac{\text{Corrective CCS} = \text{QCL} \times \text{Avg. CCS} \times F}{3}$$

Where:

$$\text{QCL} = \text{QCL of the loading division}$$

Avg. CCS = Average load unit load within the loading division for the latest study divided by the number of study hours

1 0.5
0 0

F = Factor derived from the scores and study intervals.

3 = Fixed factor

5.13 Form E-6617, for CCS correction (shown in Fig. 5), is used to determine the CCS corrective values for each load unit.

5.14 QCL and average CCS values are known for each study and remain constant for an entire loading division. The product of their multiplication is also a constant which can be multiplied by each factor F for individual load units. F remains the only unknown and is determined in the following manner.

First Study Period

Step 1:

Develop the corrective CCS values for each of the factor F possibilities. **Negative scores produce CCS to be added and positive scores produce CCS to be subtracted as shown below.** Place results at the top of the first section on Form E-6617 (the first, or beginning, study).

$$\frac{\text{Corrective CCS} = \text{QCL} \times \text{Avg. CCS} \times \text{F}}{3}$$

Step 2:

First study period scores for each load unit are listed in the first section in the column labeled SC.

Step 3:

Using each score, the F-factors are selected from the table in Step 1.

Step 4:

The appropriate CCS corrective values are taken from the top of the first section and entered for each load unit.

Subsequent Study Periods

Step 5:

Factor W is selected from the table below using the first (previous) study score. This factor is a weighted estimate of past scores for each collection interval. It is placed in column W for each load unit for the next study period.

FACTOR (W)

SCORE	FREQUENCY			
	WEEKLY	BIWEEKLY*	TRIWEEKLY	MONTHLY*
±4	3.2	2.6	2.0	1.6
±2	1.6	1.3	1.0	.8
±1	.8	.6	.5	.4
0	0	0	0	0

* Includes 4-week intervals.

Score	Factor (F)
4	3.0
2	1.0

Step 6:

Add the W-factors to each load unit score.

$$W + SC = WSC$$

Step 7:

New F-factors for this study *and projected W-factors for subsequent study periods* are shown in Figure 6 for each WSC value, depending upon the collection interval being used. New F-factors and W-factors for future studies are developed from the appropriate tables, depending on the study interval.

Step 8:

Only eight F-factors are possible for subsequent weeks: 0, 0.5, 1.0, 2.0, 3.0, 4.0, 5.0, and 6.0. Develop CCS corrective values for each of these factors with the formula below and place at the top of the appropriate column of Form E-6617.

$$\text{Corrective CCS} = \frac{\text{QCL} \times \text{Avg. CCS} \times \text{F}}{3}$$

Step 9:

The appropriate corrective CCS values are then selected from this listing for the corresponding F-factor for each load unit.

LINE ASSIGNMENT GUIDE

5.15 Once corrective CCS values are established for each load unit during a study period, a line assignment guide can be constructed in one of the two ways shown in Figure 7. Each B-link group is listed in descending order by the least CCS reduction determined earlier; that is, 4 CCS per line or 3 CCS per line. If the line assignment guides prove to be too difficult or time-consuming to develop, a third method is proposed. This procedure is simply to establish a list similar to the one which follows. Extreme care must be taken, however, when the list is used.

ESTIMATED CCS/LINE = 4

LTN	CONC GRP	CONC	CCS TO ADD	LINES TO ADD
00	0 and 4	2	70	17
01	1 and 5	0	60	15
03	2 and 6	5	54	13
03	3 and 7	2	54	13
02	3 and 7	6	53	13
01	2 and 6	7	50	13
03	0 and 4	2	46	11
00	2 and 6	1	40	10

5.16 The network administrator must still determine the order in which these lines should be assigned, what to do if sufficient spare OENs are not available in each concentrator, and how to use disconnect information.

5.17 If a score is unavailable for a group in a measurement period, it is suggested that the last period score be used in the calculation. ***When measurements are unavailable for more than one month, it is suggested that the latest study be considered as study period one and that the process begin anew.***

LINE TRANSFER GUIDE

5.18 Line transfer guides are constructed in a manner similar to the manner in which the line assignment guides are constructed; line transfer guides are used primarily for decisions pertaining to OEN transfer activities. However, the listing starts with the most heavily loaded unit rather than the lightest loaded one. The guide is developed using an average CCS or ranges of CCS, such as light CCS (LCCS), medium CCS (MCCS), or heavy CCS (HCCS), depending upon the degree of detail required for administrative purposes (Fig. 8).

5.19 Proceeding in order of removal, the network administrator lists the OEN beside each load unit under the ***Selected*** column. This listing includes the switch (Sw), level (Lev), and class of

service (CS). Disconnects would be accounted for before choosing lines to be transferred in order to avoid any overcorrection.

6. ORDERING FORMS

6.01 Forms (Code A) used in this section may be ordered from a local Western Electric

service center. Forms E-6615, E-6616, and E-6617 may be ordered in multiples of 50 per pad, 2 pads per package (the unit contains 100 forms). Full-size copies of these forms are attached to the back of this section and may be reproduced locally for interim use.

LOAD BALANCE QUALITY CONTROL LIMITS BASED ON 10 HOUR DATA								
NO. 2 ESS (2:1 & 4:1 CONCS) – FULL B-LINK GROUPS								
AVERAGE HOLDING TIME (SECS)	ACTUAL AVERAGE LOAD PERCENTAGE OF TL							
	30% TO 35%	36% TO 45%	46% TO 55%	56% TO 65%	66% TO 75%	76% TO 85%	86% TO 95%	96% & UP
0 – 70	19	17	15	14	13	12	11	11
71 – 90	22	19	17	16	15	14	13	12
91 – 110	25	22	19	18	16	15	14	14
111 – 130	27	24	21	19	18	17	16	15
131 – 150	29	26	23	21	19	18	17	16
151 – 170	31	27	24	22	21	19	18	17
171 – 190	33	29	26	24	22	21	19	18
191 – 210	35	31	27	25	23	22	20	19
211 – 230	37	32	29	26	24	23	21	20
231 – 250	39	33	30	27	25	24	22	21
251 – 270	40	35	31	28	26	25	23	22
271 – 290	42	36	32	30	27	26	24	23
291 – 310	43	37	33	31	28	27	25	24
311 – 330	45	39	35	32	29	27	26	25
331 – 350	46	40	36	33	30	28	27	25
351 – 370	47	41	37	34	31	29	27	26
371 – 390	48	42	38	34	32	30	28	27
391 – 410	50	43	39	35	33	31	29	27
411 – 430	51	44	40	36	34	31	30	28
431 – 450	52	45	41	37	34	32	30	29
451 – 470	53	46	41	38	35	33	31	29
471 – 490	54	47	42	39	36	34	32	30

Fig. 1—Load Balance Quality Control Limits—Full B-Link Groups (2.05, 2.22, 2.24, 2.28, 2.29)

LOAD BALANCE QUALITY CONTROL LIMITS BASED ON 10 HOUR DATA								
NO. 2 ESS (4:1 CONCS.) – UNPAIRED B-LINK GROUPS								
AVERAGE HOLDING TIME (SECS)	ACTUAL AVERAGE LOAD PERCENTAGE OF TL							
	30% TO 35%	36% TO 45%	46% TO 55%	56% TO 65%	66% TO 75%	76% TO 85%	86% TO 95%	96% & UP
0- 70	27	24	21	19	18	17	16	15
71- 90	32	27	25	22	21	19	18	17
91-110	35	31	27	25	23	22	20	19
111-130	39	33	30	27	25	24	22	21
131-150	42	36	32	30	27	26	24	23
151-170	45	39	35	32	29	27	26	25
171-190	47	41	37	34	31	29	27	26
191-210	50	43	39	35	33	31	29	27
211-230	53	45	41	37	34	32	30	29
231-250	55	47	42	39	36	34	32	30
251-270	57	49	44	40	37	35	33	31
271-290	59	51	46	42	39	36	34	32
291-310	61	53	47	43	40	38	35	34
311-330	63	55	49	45	41	39	37	35
331-350	65	56	50	46	43	40	38	36
351-370	67	58	52	47	44	41	39	37
371-390	69	60	53	49	45	42	40	38
391-410	70	61	55	50	46	43	41	39
411-430	72	63	56	51	47	44	42	40
431-450	74	64	57	52	49	45	43	41
451-470	75	65	59	54	50	46	44	42
471-490	77	67	60	55	51	47	45	42

Fig. 2—Load Balance Quality Control Limits—Unpaired B-Link Groups (2.05, 2.22, 2.24, 2.28, 2.29)

INSTRUCTIONS FOR PREPARING FORM E-6615

LOAD BALANCE SCORE CONTROL RECORD

BUILDING: Identify the building location.

TRAFFIC UNIT: Identify the traffic unit; eg, 241 -CCO.

PAGE OF: Number each page consecutively beginning with 1 and show total pages.

LOADING DIVISION: Identify the loading division.

LUs INSTALLED: Enter quantity of load units installed in the loading division.

LU ENG CCS: Enter the TL in CCS for a load unit in the loading division.

STUDY DATE: Enter the beginning and ending date of each study; eg, 2-9-75 through 2-15-75.

STUDY NO: These numbers may be circled to indicate the studies to be indexed when more than one study a month is made.

TOTAL CCS: Enter the total usage read on the study for the loading division. This should include usage only from load units with valid data.

LUs MEAS: Enter the quantity of load units with valid data for the study.

% OF TL
Enter the percentage that the actual load is of the TL. The method for computing this percentage is outlined in 2.23 of this section.

- (1) $\frac{\text{Total CCS}}{\text{LUs Meas}} = \text{Average weekly load per LU}$
- (2) $\frac{\text{Average Weekly Load/LU}}{\text{No. of Study Hours}} = \text{Average load (AL)/LU}$
- (3) $\frac{\text{Average Load/LU} \times 100}{\text{LU TL}} = \% \text{ TL}$

AHT: Enter the average holding time used on the study to select QCLs. The method is outlined in 2.24 of this section.

% COLUMN

+2: The average CCS will be considered as 100 percent. Add the QCL figure (percentage) found in the tables to 100 and enter here.

+1: Add half the QCL figure to 100 and enter here.

0: The average is considered as 100 percent.

-1: Subtract half the QCL figure from 100 and enter here.

-2: Subtract the QCL figure from 100 and enter here.

CCS COLUMN

+2: Multiply the figure in “%” column times the average CCS, divide by 100, round all fractions to the nearest whole number, and enter here: eg, 1231.6 would be entered as 1232, the upper limit for +2 scores.

+1: Multiply the figure in “%” column times the average CCS, divide by 100, round fractions to the nearest whole number, and enter here.

0: Divide the total CCS read on the study by the quantity of load units having valid data on the study, round fractions to the nearest whole number, and enter here.

-1: Multiply the figure in “%” column times the average CCS, divide by 100, round fractions to the nearest whole number, and enter here; eg, 1231.2 would be entered as 1231.

-2: Multiply the figure in “%” column times the average CCS, divide by 100, round fractions to the nearest whole number, and enter here.

LOAD BALANCE SCORE CONTROL RECORD														Form E6615 (5-75)	
Building: BELL				Traffic Unit: 241-CCO				Page 3 of 4							
LOADING DIVISION -				LUs INSTALLED 192				LU ENG. CCS 230							
STUDY DATE	2/9-2/15			2/15-2/21			2/21-2/27								
STUDY NO.	①			2			③			4			5		
TOTAL CCS	249,600			259,200			261,421								
LUs MEAS.	192			192			192								
% ENG. CAP.	57			59			60								
AVG. H.T.	212			214			215								
	%	CCS	%	CCS	%	CCS	%	CCS	%	CCS	%	CCS	%	CCS	
+2	126	1638	126	1701	126	1716									
+1	113	1469	113	1526	113	1539									
0	AVG.	1300	AVG.	1350	AVG.	1362	AVG.		AVG.		AVG.		AVG.		
1	87	1131	87	1175	87	1185									
-2	74	962	74	999	74	1008									
LOADING DIVISION _____				LUs INSTALLED _____				LU ENG. CCS _____							
STUDY DATE															
STUDY NO.	1			2			3			4			5		
TOTAL CCS															
LUs MEAS.															
% ENG. CAP.															
AVG. H.T.															
	%	CCS	%	CCS	%	CCS	%	CCS	%	CCS	%	CCS	%	CCS	
+2															
+1															
0	AVG.		AVG.		AVG.		AVG.		AVG.		AVG.		AVG.		
1															
2															
LOADING DIVISION _____				LUs INSTALLED _____				LU ENG. CCS _____							
STUDY DATE															
STUDY NO.	1			2			3			4			5		
TOTAL CCS															
LUs MEAS.															
ENG CAP.															
AVG H T															
	%	CCS	%	CCS	%	CCS	%	CCS	%	CCS	%	CCS	%	CCS	
+2															
+1															
0	AVG.		AVG.		AVG.		AVG.		AVG.		AVG.		AVG.		
1															
2															

Fig. 3—Load Balance Score Control Record (5.04)

INSTRUCTIONS FOR PREPARING FORM E-6616

LOAD UNIT - LOAD BALANCE CHART

- BUILDING:** Identify building location.
- LOADING DIVISION:** Identify the loading division.
- TRAFFIC UNIT:** Identify the traffic unit.
- LU_s INSTALLED:** Enter quantity of load units installed in the loading division.
- PAGE OF** Number each page consecutively beginning with 1 and show total pages to list all load units in the loading division.
- STUDY DATE:** Enter the beginning and ending dates of the study; eg, 2-9-75 through 2-15-75.
- STUDY NO.:** These numbers may be circled to indicate the studies to be indexed when more than one study per month is made.
- LTN-LLN-FR:** Enter the line trunk network, line link network, or frame number when required to distinguish among load units.
- LG-HG-CONC CONC GRP:** Cross out the three not applicable. Enter the line group, horizontal group, concentrator, or concentrator group identification.
- CCS:** Enter the weeks usage reading for the load unit (LG, HG, Conc, or Conc Grp) on the study.
- S-P-H:** These spaces stand for score (S), penalty (P), and hot-spot penalty points (H). Detailed information regarding the development of P and H is found in Dial Facilities Management Practices, Division A, Section 5b, Load Balance Index Plan.
- The S space is for entering the study score for the load unit. The +4 scores for indexed studies may be highlighted for ease of counting penalty points.
 - The P space is for entering the total penalty points for the report month. It is suggested that these be entered only when the load unit results are to be reported in the index.
 - The H space is for entering the total hot-spot penalty points for the index report month.

LOAD UNIT-LOAD BALANCE CHART										Form E-6616 (5-75)	
Building: BELL			Traffic Unit: 241-CCO			Page 1 of 6					
Loading Division: ---			LU Installed: 192								
LTN LLN FR	LG HG Conc Conc Grp	STUDY DATE	2/9-2/15			2/23-3/1			3/9-3/15		
			STUDY NO.	1	2	3	4	5	6	7	
00	of 4-0	CCS	1730	1710	1725						
		S P H	+4 3 -	+4 3 -	+4 3 -						
1	}	CCS	967	1215	1413						
		S P H	-2 - -	-1 - -	+1 - -						
2	}	CCS	1379	1540	1569						
		S P H	+1 - -	+2 - -	+2 - -						
3	}	CCS	1510	1480	1476						
		S P H	+2 - -	+1 - -	+1 - -						
4	}	CCS	960	1015	1190						
		S P H	-4 - -	-2 - -	-1 - -						
5	}	CCS	1141	1160	1175						
		S P H	-1 - -	-2 - -	-2 - -						
6	}	CCS	1050	980	1026						
		S P H	-2 - -	-4 - -	-2 - -						
of 4-7		CCS	1174	1191	1210						
		S P H	-1 - -	-1 - -	-1 - -						
		CCS									
		S P H									
		CCS									
		S P H									
		CCS									
		S P H									
		CCS									
		S P H									
		CCS									
		S P H									
		CCS									
		S P H									
		CCS									
		S P H									
		CCS									
		S P H									
		CCS									
		S P H									
		CCS									
		S P H									

S-Study Score
P-Penalty Points
H-Hot Spot Penalty Points

Fig. 4—Load Unit-Load Balance Chart (5.04)

CCS CORRECTION

BUILDING: BELL						TRAFFIC UNIT: 241-CCO					LOAD UNITS: 192						
LOAD UNIT	F	STUDY 2/9 - 2/15					STUDY 2/23 - 3/1					STUDY					
		W	SC	WSC	F	CCS CORR.	W	SC	WSC	F	CCS CORR.	W	SC	WSC	F	CCS CORR.	
		Q/3 X AVG. CCS X F					Q/3 X AVG. CCS X F					Q/3 X AVG. CCS X F					
	.5	$0.09 \times 130 \times 0.5 = 6$					$0.09 \times 135 \times 0.5 = 6$										
	1.0	$0.09 \times 130 \times 1.0 = 12$					$0.09 \times 135 \times 1.0 = 12$										
	2.0						$0.09 \times 135 \times 2.0 = 24$										
	3.0	$0.09 \times 130 \times 3.0 = 35$					$0.09 \times 135 \times 3.0 = 36$										
	4.0						$0.09 \times 135 \times 4.0 = 49$										
	5.0						$0.09 \times 135 \times 5.0 = 61$										
	6.0						$0.09 \times 135 \times 6.0 = 73$										
00-244	0		+4		3.0	-35	2.6	+4	6.6	6.0	-73	2.6					
	1		-2		1.0	+12	0.6	-1	1.6	0.5	+6	0.6					
	2		+1		0.5	-6	1.3	+2	3.3	1.0	-12	1.3					
	3		+2		1.0	-12	0.6	+1	1.6	0.5	-6	0.6					
	4		-4		3.0	+35	1.3	-2	3.3	1.0	+12	1.3					
	5		-1		0.5	+6	1.3	-2	3.3	1.0	+12	1.3					
	6		-2		1.0	+12	2.6	-4	6.6	6.0	+73	2.6					
	7		-1		0.5	+6	0.6	-1	1.6	0.5	+6	0.6					
00-145	0																
	1																
	2																
	3																
	4																
	5																
	6																
	7																
00-246	0																
	1																
	2																
	3																
	4																
	5																
	6																
	7																

Fig. 5—CCS Correction (5.13)

SECTION 10g

FACTORS (W) & (F)											
WEEKLY						BIWEEKLY					
WSC	W	F	WSC	W	F	WSC	W	F	WSC	W	F
0	0	0	3.6	1.6	1.0	0	0	0	3.4	1.3	2.0
.1	0	0	3.7	1.6	2.0	.1	0	0	3.5	1.4	2.0
.2	.1	0	3.8	1.7	2.0	.2	.1	0	3.6	1.4	2.0
.3	.1	0	3.9	1.7	2.0	.3	.1	0	3.7	1.4	2.0
.4	.2	0	4.0	1.8	2.0	.4	.2	0	3.8	1.5	2.0
.5	.2	0	4.1	1.8	2.0	.5	.2	0	3.9	1.5	2.0
.6	.3	0	4.2	1.9	2.0	.6	.2	0	4.0	1.6	2.0
.7	.3	0	4.3	1.9	2.0	.7	.3	0	4.1	1.6	2.0
.8	.4	0	4.4	2.0	2.0	.8	.3	0	4.2	1.6	2.0
.9	.4	0	4.5	2.0	2.0	.9	.4	0	4.3	1.7	2.0
1.0	.4	0	4.6	2.0	2.0	1.0	.4	0	4.4	1.7	2.0
1.1	.5	0	4.7	2.1	2.0	1.1	.4	.5	4.5	1.8	2.0
1.2	.5	.5	4.8	2.1	2.0	1.2	.5	.5	4.6	1.8	2.0
1.3	.6	.5	4.9	2.2	2.0	1.3	.5	.5	4.7	1.8	2.0
1.4	.6	.5	5.0	2.2	2.0	1.4	.5	.5	4.8	1.9	2.0
1.5	.7	.5	5.1	2.3	2.0	1.5	.6	.5	4.9	1.9	3.0
1.6	.7	.5	5.2	2.3	2.0	1.6	.6	.5	5.0	2.0	3.0
1.7	.8	.5	5.3	2.4	2.0	1.7	.7	.5	5.1	2.0	3.0
1.8	.8	.5	5.4	2.4	3.0	1.8	.7	.5	5.2	2.0	3.0
1.9	.8	.5	5.5	2.4	3.0	1.9	.7	.5	5.3	2.1	3.0
2.0	.9	.5	5.6	2.5	3.0	2.0	.8	.5	5.4	2.1	3.0
2.1	.9	.5	5.7	2.5	3.0	2.1	.8	1.0	5.5	2.1	3.0
2.2	1.0	.5	5.8	2.6	3.0	2.2	.9	1.0	5.6	2.2	3.0
2.3	1.0	1.0	5.9	2.6	3.0	2.3	.9	1.0	5.7	2.2	4.0
2.4	1.1	1.0	6.0	2.7	3.0	2.4	.9	1.0	5.8	2.3	4.0
2.5	1.1	1.0	6.1	2.7	3.0	2.5	1.0	1.0	5.9	2.3	4.0
2.6	1.2	1.0	6.2	2.8	3.0	2.6	1.0	1.0	6.0	2.3	4.0
2.7	1.2	1.0	6.3	2.8	4.0	2.7	1.1	1.0	6.1	2.4	4.0
2.8	1.2	1.0	6.4	2.8	4.0	2.8	1.1	1.0	6.2	2.4	4.0
2.9	1.3	1.0	6.5	2.9	4.0	2.9	1.1	1.0	6.3	2.5	4.0
3.0	1.3	1.0	6.6	2.9	4.0	3.0	1.2	1.0	6.4	2.5	5.0
3.1	1.4	1.0	6.7	3.0	4.0	3.1	1.2	1.0	6.5	2.5	6.0
3.2	1.4	1.0	6.8	3.0	4.0	3.2	1.2	1.0	6.6	2.6	6.0
3.3	1.5	1.0	6.9	3.1	4.0	3.3	1.3	1.0			
3.4	1.5	1.0	7.0	3.1	5.0						
3.5	1.6	1.0	7.1	3.2	5.0						
			7.2	3.2	6.0						

Fig. 6—W and F Factors (Sheet 1 of 2) (5.14)

FACTORS (W) & (F)											
TRIWEEKLY						MONTHLY					
WSC	W	F	WSC	W	F	WSC	W	F	WSC	W	F
0	0	0	3.0	1.0	1.0	0	0	0	2.9	.8	2.0
.1	0	0	3.1	1.0	2.0	.1	0	0	3.0	.9	2.0
.2	.1	0	3.2	1.1	2.0	.2	.1	0	3.1	.9	2.0
.3	.1	0	3.3	1.1	2.0	.3	.1	0	3.2	.9	2.0
.4	.1	0	3.4	1.2	2.0	.4	.1	0	3.3	1.0	2.0
.5	.2	0	3.5	1.2	2.0	.5	.1	0	3.4	1.0	2.0
.6	.2	0	3.6	1.2	2.0	.6	.2	0	3.5	1.0	2.0
.7	.2	0	3.7	1.3	2.0	.7	.2	0	3.6	1.0	2.0
.8	.3	0	3.8	1.3	2.0	.8	.2	0	3.7	1.1	2.0
.9	.3	0	3.9	1.3	2.0	.9	.3	0	3.8	1.1	2.0
1.0	.3	.5	4.0	1.4	2.0	1.0	.3	.5	3.9	1.1	2.0
1.1	.4	.5	4.1	1.4	2.0	1.1	.3	.5	4.0	1.2	2.0
1.2	.4	.5	4.2	1.4	2.0	1.2	.3	.5	4.1	1.2	2.0
1.3	.4	.5	4.3	1.5	2.0	1.3	.4	.5	4.2	1.2	3.0
1.4	.5	.5	4.4	1.5	2.0	1.4	.4	.5	4.3	1.2	3.0
1.5	.5	.5	4.5	1.5	3.0	1.5	.4	.5	4.4	1.3	3.0
1.6	.5	.5	4.6	1.6	3.0	1.6	.5	.5	4.5	1.3	3.0
1.7	.6	.5	4.7	1.6	3.0	1.7	.5	.5	4.6	1.3	3.0
1.8	.6	.5	4.8	1.6	3.0	1.8	.5	1.0	4.7	1.4	3.0
1.9	.6	1.0	4.9	1.7	3.0	1.9	.6	1.0	4.8	1.4	3.0
2.0	.7	1.0	5.0	1.7	3.0	2.0	.6	1.0	4.9	1.4	4.0
2.1	.7	1.0	5.1	1.7	3.0	2.1	.6	1.0	5.0	1.5	4.0
2.2	.7	1.0	5.2	1.8	3.0	2.2	.6	1.0	5.1	1.5	4.0
2.3	.8	1.0	5.3	1.8	4.0	2.3	.7	1.0	5.2	1.5	4.0
2.4	.8	1.0	5.4	1.8	4.0	2.4	.7	1.0	5.3	1.5	4.0
2.5	.8	1.0	5.5	1.9	4.0	2.5	.7	1.0	5.4	1.6	4.0
2.6	.9	1.0	5.6	1.9	4.0	2.6	.8	1.0	5.5	1.6	5.0
2.7	.9	1.0	5.7	1.9	4.0	2.7	.8	1.0	5.6	1.6	6.0
2.8	.9	1.0	5.8	2.0	4.0	2.8	.8	1.0			
2.9	1.0	1.0	5.9	2.0	5.0						
			6.0	2.6	6.0						

Fig. 6—W and F Factors (Sheet 2 of 2) (5.14)

LINE ASSIGNMENT GUIDE – PROCEDURE 1

CCS Capacity = 230
 Estimated CCS/LINE = 4

DESIRED ORDER OF ASSIGNMENT	CCS TO ADD	LTN-CONC. GRP. CONC. NO.	ASSIGNED				DISCONNECT			
			SW	LEV	CS	LIST NO.	SW	LEV	CS	---
1	70	00-0 and ④-2	6	2	1FR	5				
2	66	00-0 and ④-2	4	0	1FR	5				
3	62	00-0 and ④-2	0	1	1FR	5				
4	60	00-① and 5-5	4	3	2FR	6				
5	58	00-0 and 4-2	NA				4	3	1FR	
6	56	00-① and 5-5	3	3	1FR	5				
7	54	00-0 and ④-2	NA				2	1	1FR	
8	54	01-2 and ⑥-3	7	3	1FR	5				
9	54	02-3 and 7-7	NA							
10	53	03-1 and ⑤-0	7	2	2FR	6				
11	52	00-1 and ⑤-5	2	1	2FR	6				
12	50	00-0 and 4-2	NA							
13	50	01-② and 6-3	5	2	1FR	5				
14	50	02-3 and 7-7	NA							
15	49	03-① and 5-0	6	3	2MR	7				
16	48	00-1 and ⑤-5	1	0	2MR	7				

Fig. 7—Line Assignment Guide Procedures (Sheet 1 of 2) (5.15)

LINE ASSIGNMENT GUIDE – PROCEDURE 2

CCS Capacity = 230 LCCS = 3
 MCCS = 6
 HCCS = 9

DESIRED ORDER OF ASSIGNMENT	CCS TO ADD	LTN-CONC. GRP. CONC. NO.	ASSIGNED				DISCONNECT				
			SW	LEV	CS	LIST NO.	SW	LEV	CS	___	
1	70	01-0 and ④-7	L	5	2	1MR	10				
2	67	01-0 and 4-7									
3	64	01-① and 4-7	M	4	3	2FR	11				
4	61	01-0 and ④-7	L	1	0	1MR	10				
5	60	03-② and 6-3	L	0	1	1MR	10				
6	58	01-0 and 4-7									
7	57	03-2 and 6-3									
8	55	01-0 and 4-7									
9	54	03-2 and ⑥-3	M	3	3	2FR	11				
10	54	02-1 and 5-6									
11	54	00-3 and 7-5	NA					0	1		
12	53	03-0 and ④-2	L	6	2	1MR	10				
13	52	01-① and 4-7	H	6	3	1FR	12				
14	51	03-2 and 6-3	NA								
15	51	02-1 and ⑤-6	M	2	1	2FR	11				
16	51	00-3 and 7-5	NA					3	2		

Fig. 7—Line Assignment Guide Procedures (Sheet 2 of 2) (5.15)

LINE TRANSFER GUIDE – PROCEDURE 1

CCS Capacity = 230
 Estimated CCS/LINE = 4

DESIRED ORDER OF ASSIGNMENT	CCS TO REMOVE	LTN-CONC. GRP. CONC. NO.	SELECTED				DISCONNECT			
			SW	LEV	CS	LIST NO.	SW	LEV	CS	---
1	70	00-2 and ⑥-1	2	0	1FR	10				
2	66	00-②and 6-1	7	2	2FR	10				
3	62	00-2 and ⑥-1	0	2	1FR	10				
4	60	01-①and 4-7	2	1	2MR	10				
5	58	00-2 and 6-1	—	—			3	0		
6	56	01-0 and ④-7	3	1	1FR	10				
7	54	00-2 and 6-1	—	—			1	3		
8	54	00-2 and ⑥-5	5	1	2FR	10				
9	54	03-0 and 4-3	—	—			0	3		
10	53	01-3 and ⑦-5	4	3	1FR	10				
11	52	01-①and 4-7	1	2	1FR	10				
12	50	03-0 and 4-3	—	—			6	2		
13	50	00-②and 6-1	6	3	WFA	10				
14	50	01-1 and 5-2	—	—			7	2		
15	50	00-②and 6-5	4	0	1FR	10				
16	49	01-③and 7-5	6	2	1FR	10				

Fig. 8—Line Transfer Guide Procedures (Sheet 1 of 2) (5.18)

LINE TRANSFER GUIDE -- PROCEDURE 2

CCS Capacity = 230 LCCS = 3
 MCCS = 6
 HCCS = 9

DESIRED ORDER OF ASSIGNMENT	CCS TO REMOVE	LTN-CONC. GRP. CONC. NO.	SELECTED				DISCONNECT				
			SW	LEV	CS	LIST NO.	SW	LEV	CS		
1	70	01- 3 and 7-4	L	2	0	1MR	9				
2	67	01- 3 and 7-4	L	7	2	1MR	9				
3	64	01- 3 and 7-4	L	0	2	1MR	9				
4	63	02-1 and 5 -4	L	2	1	1MR	9				
5	61	01-3 and 7-4	-	-	-	-	-	3			
6	60	02- 1 and 5-4	L	3	1	1MR	9				
7	58	01-3 and 7-4	-	-	-	1MR		1			
8	58	02-2 and 4 -2	L	5	1	1MR	9				
9	57	02-1 and 5-4	-	-	-	-	-	0	4		
10	55	01-3 and 7 -4	H	4	3	WFA	9				
11	55	02- 2 and 4-2	L	1	2	1MR	9				
12	54	02-1 and 5-4	-	-	-	-	-	6	2		
13	52	01-3 and 7 -4	L	6	3	1MR	9				
14	52	02- 2 and 4-2	L	3	1	1MR	9				
15	51	02-1 and 5-4	-	-	-	-	-	7	2		
16	49	01- 3 and 7-4	L	6	2	1MR	9				
17	49	02- 2 and 4-2	L	5	1	1MR	9				

Fig. 8—Line Transfer Guide Procedures (Sheet 2 of 2) (5.18)

LOAD UNIT-LOAD BALANCE CHART

Form E-6616
(5-75)

Building:	Traffic Unit:	Page of
Loading Division:	LU Installed:	

LTN LLN FR	LG HG Conc Conc Grp	STUDY DATE								
		STUDY NO.	1.	2.	3.	4.	5.	6.	7.	
		CCS								
		S P H								
		CCS								
		S P H								
		CCS								
		S P H								
		CCS								
		S P H								
		CCS								
		S P H								
		CCS								
		S P H								
		CCS								
		S P H								
		CCS								
		S P H								
		CCS								
		S P H								
		CCS								
		S P H								

S-Study Score
P-Penalty Points
H-Hot Spot Penalty Points

