SWITCHING SYSTEMS MANAGEMENT
NO. 1 CROSSBAR
LOAD BALANCING PROCEDURES

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1. GENERAL

PURPOSE

1.01 This section describes load balancing techniques primarily as they relate to horizontal group balance in No. 1 Crossbar offices. Included is a description of how these techniques are incorporated into the new load balance index (LBI) described in Dial Facilities Management Practices (DFMPs), Division A, Section 5b, Load Balance Index Plan.

1.02 When this section is reissued, this paragraph will contain the reason for reissue.

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

1.04 This section is a full revision and consolidation of many documents on the subject of load and balance. In conjunction with DFMP, Division A, Section 5b, this section replaces TL562 which transmitted the previous overall balance index plan, issued July 13, 1966; subsequent modification was made by TWX (March 1, 1967 and August 21, 1967).

1.05 This section replaces all parts of the Central Office Management Guide, Division E, Section 4, which describe line balance by class-of-service and by line loading including the development and interpretation of the score system and quality control limits.

1.06 While balancing and indexing may both be based on the same usage data, data qualifications for indexing puposes are more stringent to ensure uniformity among all offices. Thus, DFMP, Division A, Section 5b is the final arbiter of data requirements and procedures required for index generation.

RESPONSIBILITIES

1.07 The network administrator has the responsibility for load balance and index reporting. In order to achieve the objectives of good load balance, this responsibility includes:

(1) Busy hour and side hour determination

(2) Scheduling studies

(3) Data collection

(4) Preparation of loading plans

(5) Preparation of load balance forms

(6) Preparation of customer line usage assignment forms

(7) Data validation

(8) Analysis and corrective action

(9) Preparation and distribution of the load balance index form.

2. PRINCIPLES OF LOAD BALANCE

DEFINITION OF TERMS

2.01 The definition of a ***traffic unit*** is the same as the definition of a ***dial entity.*** The term traffic unit is used to conform with the common language location identification practice, Bell System Practices Section 795-100-100. Examples of traffic units are as follows:

(a) ***Step-By-Step:*** A group of lines requiring use of the same intermediate distributing frame.

(b) ***Panel:*** A group of lines using a common decoder group or having common translator arrangements.

(c) ***No. 1 Crossbar:*** A group of lines using a common terminating marker group.

(d) ***No. 5 Crossbar:*** A group of lines using a common marker group.

(e) ***Electronic Switching Systems:*** A group of lines associated with one central control system using the same logic and processor.

2.02 A ***load unit*** is defined as that component of line originating equipment arranged for usage measurements and for which individual scores are to be computed. A load unit in a No. 1 Crossbar traffic unit is the horizontal group (HG).

2.03 The general definition of a ***loading division*** is a group of load units of the same type of dial equipment, designed to be loaded similarly by both usage and classes of service and not requiring telephone number changes to effect line load balance within the loading division. Where equipment features, such as TOUCH-TONE®, prevent similar loading and assigning due to equipment design, the operating telephone company (OTC) has the option of further breakdowns by loading divisions. Uniformity of justification for creating more loading divisions should be maintained within an OTC. Care should be taken that the establishment of additional loading divisions does not create undetectable imbalances in other equipment components. Creation of more than one loading division requires administration for proper loading between divisions.

2.04 Loading divisions of the same class-of-service, possessing only slightly different capacities, may conveniently be combined in order to assign customer lines. Combinations of this type are called ***assignment divisions.***

2.05 A ***study*** is the period of time scheduled to measure and score the usage to determine load balance by quality control techniques.

2.06 The ***class busy hour (CBH)*** is the time consistent hour during which a loading division has the highest average hundred call seconds (CCS) usage measured for five days during the same week. The hour may start and end on the clock hour or half-hour.

2.07 A ***side hour*** is an amount of time equal to one hour that is time consistent and adjacent to the CBH. It may be on one side or both sides of the CBH in order to provide the highest possible CCS for the side hour, but must not be divided into time periods of less than one half of an hour. For example, if the CBH is 9:00 to 10:00 am, the side hour could be 8:00 to 9:00 am, or 10:00 to 11:00 am, or 8:30 to 9:00 am, and 10:00 to 10:30 am.

2.08 ***Session busy hours (SBHs)*** are comprised of the CBH and the side hour if the side hour has average weekly usage equal to at least 90 percent of the CBH during the busy season and at least 80 percent of the CBH during the nonbusy season studies.

BALANCE BY LOADING DIVISION

2.09 Studies show that good load balance is required if the inherent call carrying capacity of a traffic unit is to be satisfactorily achieved. A good loading plan is one that improves balance at each opportunity and assures optimum balance during periods of peak loads. It recognizes that as engineered capacities are reached or exceeded, intensified administrative attention to balance is needed to assure that service goals will then be met. Good loading plans maintain balance between all loading divisions and traffic units in a wire center.

2.10 ***Perfect balance*** might be thought of as a condition where customer usage is so distributed that each load unit within a loading division carries exactly its proportionate share of the total load. As customer-offered loads always vary, by chance, from day to day and week to week, such ***perfect balance*** is not a practical or even meaningful goal. Furthermore, due to these chance variations, load studies can never be taken as exact measurements of the state of balance.

If, however, the measured variations among the load units do not exceed a reasonable estimate of the largest possible chance variation, a good ***practical balance*** exists. The intent of this section is to assist the administrator in achieving this good practical balance.

2.11 Balance requires constant analysis of the changes in horizontal group loads and of the effects on service. A single horizontal group which appears to have a load substantially above average in one week may be below average the next week without having had any assignment changes or corrective action applied to it. The trend is important as well as the relative position of a horizontal group for any given study period.

2.12 The degree of balance within a traffic unit affects three important phases of the administrative job. The first, of course, is service. Balancing improves service by reducing the possibility of switching blockages, thus minimizing customer dissatisfaction which should, in turn, reduce calls to repair service. A second important item is effective utilization of equipment (maximum utilization of capacity). Whenever a balanced condition exists among horizontal groups of a loading division, the best possible maintenance condition will result because of even wear on equipment components. Finally, a well-balanced traffic unit provides reliable data that show sound load-service relationships. This is conducive to engineering correct equipment quantities and the anticipation of future service levels.

2.13 Good balance also is important in underloaded traffic units as a safeguard against the results of unforeseeable heavy loads and in preparation for busy season or other anticipated loads. It is difficult, time-consuming, and expensive to rebalance a traffic unit once it has been permitted to get out of balance. A traffic unit that is out of balance and is being brought back into balance by the issuance of line transfers over a relatively short time span is likely to fall short of the degree of balance expected. Therefore, advantage should always be taken of directed line assignments to improve the balance within a unit.

BALANCE BY CLASS OF SERVICE

2.14 In addition to the distribution of CCS usage, it is important to maintain a good distribution by classes of service among horizontal groups in a mixed class-of-service loading division to give them similar traffic characteristics. Balancing techniques which use load measurements alone may inadvertently lead to a poor class-of-service mix causing the horizontal groups to vary in an irregular manner from day-to-day and from hour-to-hour. Typical of these circumstances are: Friday evening business loads caused by shopping centers or local sports activities, early school dismissals, weather problems, social conditions, sudden stock market activities, etc. Results are most unsatisfactory when there are periods of heavy load that occur daily or frequently at times other than the traffic unit busy hour(s) used for load balancing or network engineering purposes.

2.15 While a good class-of-service mix does not prevent load fluctuations, it does tend to spread them across all horizontal groups, thereby helping to maintain a uniform balance condition. A balance which includes good distribution by usage and by class-of-service will aid in deriving maximum utilization of central office equipment while producing the best possible service to the customer. It should also reduce tendencies toward separate load and service busy hours and minimize the number of horizontal groups having busy hours differing from the loading division busy hour. When separate load and service busy hours exist that do not appear to be satisfactorily minimized by a class-of-service redistribution, the appropriate Company staff group and the AT&T Company Network Administration Group should be informed before extensive special procedures are undertaken.

SERVICE INDICATORS

2.16 The degrees of effort and attention to be given a particular traffic unit in regard to balance will depend to a large degree on the service level in that office. Primarily this will be indicated by the network switching performance measurement plan especially those components most sensitive to the level of loading such as dial tone speed and matching loss. During the busy season, a traffic unit with a good index should not require line transfers for balance but should be able to rely primarily on effective line assignment procedures.

2.17 A traffic unit that is experiencing poor service will require efforts to determine the extent to which balance is contributing to the problem. Poor dial tone speed results may be caused by poor balance or may have no relation to balance at all depending on the traffic unit configuration and problem.

2.18 Out of the busy season and in other periods of light loading more reliance must be placed on other than the measurement plan. The relationship of lost (or delayed) calls to offered load (load-service curves) becomes more important. Procedures for analysis of problem conditions are adequately described in DFMP, Division H, Section 4d(3), Problem Analysis and Corrective Action.

DETERMINATION OF BALANCE PERIODS, BUSY HOURS, AND SIDE HOURS

2.19 ***Busy hour*** studies should be taken periodically for the purpose of determining busy hours for engineering and administrative purposes. After the busy hour has been determined, side hours and balance periods may be easily selected.

2.20 The hours on either side of the busy hour in most cases will be close to the busy hour in CCS and will have the same general traffic characteristics as the busy hour. Where the usages in a side hour is at least ***90 percent of the busy hour load*** during the busy season, it should be used with the busy hour for balancing purposes. Out of the busy season, the side hour should have at least ***80 percent of the busy hour load.***

2.21 Since the 10-hour study is ***mandatory*** for the load balance index system, the 10-hour period is also recommended for regular balance studies (those weeks not reported for the LBI). Ten-hour study periods can be developed using one of the following methods:

(a) Use the busy hour and two periods adjoining the busy hour. For example:

PRIOR	BUSY HOUR	AFTER
2:30-3:00	3:00-4:00	4:00-4:30

If the load from the combined side period is at least 90 percent (80 percent nonbusy season) of the busy hour load, it can be utilized.

(b) Use the busy hour and one adjoining side hour that is at least 90 percent (80 percent nonbusy season) of the busy hour load.

(c) Use the busy hour for two adjacent weeks.

2.22 The combination of CCS from nonadjacent busy hours, such as a combination of 10:00 to 11:00 am with 7:00 to 8:00 pm is ***not acceptable*** since, in most cases, the two periods will have different traffic characteristics. An inordinate investment of time and money would have to be made in order to ascertain similarities between these periods. Bell Telephone Laboratories has conducted a study which indicates that, in virtually every case, the characteristics are different for nonadjacent busy hours. Therefore, combining nonadjacent hours will ***not be allowed.***

2.23 Where there are two distinct nonadjacent hours, the busy hour and another, that are almost equal in their CCS load levels, it may be necessary to study both periods separately. Line assignment procedures should call for assignment into those horizontal groups which are found to have below average loading in both periods with consideration for proper class-of-service distribution. As stated previously, a combination of two different periods with different characteristics, even though 90 percent of the busy hour, will most likely produce misleading balancing information.

2.24 With 10-hour studies required for load balance index reporting, 5-hour studies will present a more difficult administrative problem and will become more difficult to justify. In addition, 5-hour studies lack the statistical reliability of 10-hour studies and their use is recommended only in instances where balance conditions indicate some action is required prior to the acquisition of more statistically accurate data. Two 5-hour studies from adjacent weeks may be utilized quite effectively, however, by combining them into one 10-hour study. These data may then be used for index reporting purposes when necessary. With register grouping, combining two 5-hour periods may become necessary to obtain the 10 hours for index reporting (see 4.07 through 4.10).

2.25 Loading divisions of different classes of service are more likely to have different study period requirements (coin and noncoin). A common study period would be appropriate for all divisions having the same number of study hours and having the study commencing and terminating within one-half hour of the principal loading division (or grouping of class-of-service loading divisions).

2.26 Load balancing data for all loading divisions should be collected as frequently as required to insure good balance with a minimum of 10 hours a month. The 10-hour minimum is imposed by the load balance index requirement.

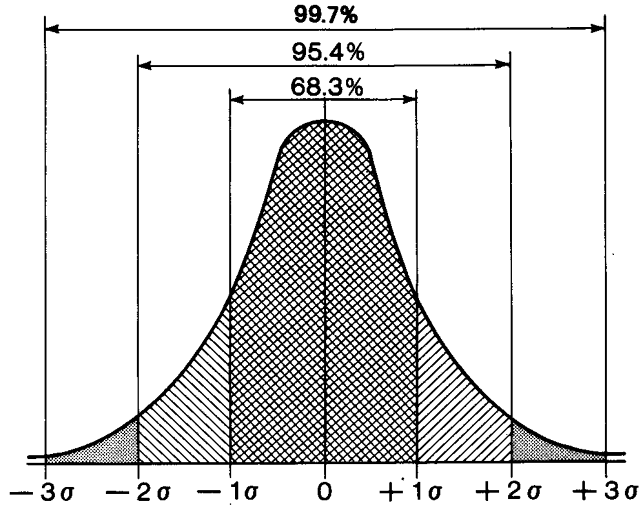
QUALITY CONTROL LIMITS

2.27 The quality control technique discussed below is a practical way of using mathematics in order to create a uniform approach to load balance procedures. This technique indicates reliably whether fluctuations in load data might be the result of chance or are probably the result of differences in traffic unit performance and consequently indicate whether or not some action should be taken. A successful quality control plan requires limits to be used that will satisfactorily and accurately indicate a true imbalance.

2.28 There are two primary causes for variation of an individual load unit's usage from the average of a number of groups in the same loading division; they are ***chance*** and ***imbalance.*** Chance variations result from the random calling patterns of customers using their telephones. The size of chance variations depend upon certain measurable characteristics; average holding time (AHT) of calls and percentage of loading of the loading division. The general rule is: the larger the sample measured, the smaller the chance variation relative to the size of the sample. Each of the characteristics listed above affect the size of samples observed in load studies.

2.29 It can be demonstrated that horizontal group variations due to chance in a reasonably balanced loading division will follow the normal distribution pattern, which is a bell-shaped distribution about the mean (average). This normal distribution can be described by stipulating a mean value and the measure of dispersion of horizontal group loads around that value. The measure of dispersion, adjusted for the number of hours of data, is commonly called the standard deviation. Traffic unit trends will not be a factor since each horizontal group is related to the average of all groups every time a record is taken. An area representing one standard deviation from the mean in a normal distribution may be expected to include 68.3 percent of all the horizontal group measurements, two standard deviations 95.4 percent of all measurements, and three standard deviations 99.7 percent of all measurements. This is illustrated in the distribution curve which follows.

Normal Distribution . . .



2.30 The problem of isolating and evaluating chance variation may be resolved by utilizing procedures involving the standard deviation. In this way the size of a deviation from the mean may be used to judge whether that deviation may be due to chance or is most probably due to imbalance. As a basis for this judgment, standard quality control limits (QCLs) representing three standard deviations have been developed. (This approach is arbitrary and is used by many industries to indicate items not meeting manufacturing tolerances.) To see what this means, consider 1000 groups for which the measured loads are averaged together. The mathematical analysis indicates that only three (the 0.3 percent outside the 99.7 percent) of those measurements can 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 QCLs are due to imbalance. Choosing larger QCLs would increase this assurance; however, there will be a greater chance that some deviations that truly reflect imbalance will be ignored. These three standard deviations (3 sigma) limits are shown in the quality control limit charts in Fig. 1.

2.31 There are two steps required in determining the appropriate QCL. The first step is to calculate the ***percentage of capacity*** for the study period. This is accomplished by taking the actual average load and comparing it to the engineered load. The QCL value derived from this computation makes allowance for the fact that horizontal group loads in a lightly loaded traffic unit can fluctuate more than those in a comparable heavily loaded unit.

2.32 This computation is made by dividing the total actual average usage (in CCS) per load unit by the engineered load (in CCS) per load unit and multiplying the result by 100. Theoretical line link frame (LLF) capacities may be found in the Traffic Facilities Practices (TFPs), Division D, Section 2b-2 or obtained from the network design engineer responsible for the traffic unit. The answer will be the ***percentage of capacity*** at which the horizontal groups are operating for the given study period. This is done for each loading division and where only sample usage is read, usage must be calculated. (See 3.45 through 3.65 for specific details with multiple loading divisions.) The percentage is then used to determine the table from which the QCL will be selected for that loading division. There are eight of these tables to cover the percentage of loading ranges from 30 percent to over 96 percent. The calculation of the percentage of capacity for the study period is illustrated in the following example:

Office Parameters:

LLFs installed = 40 (400 horizontal groups)
ILFs installed = 10
Pattern = 40 × 10 MIG (modified incoming group)
Percent terminating = 50 percent

Step 1:

LLF capacity = 1440 CCS (TFP, Division D, Section 2b-2)

Horizontal group capacity = 144 CCS

ie, Theoretical engineered load (EL) = 144 CCS

Step 2:

LLF CCS = Terminating + Originating
LLF CCS = ILF SU × T/S + DJ CCS

Marker total channel PC (TCPC) = 12703
Marker sample channel PC (SCPC) = 3282
Incoming link frame usage (DGU) = SU = 6293
District junctor CCS = 29082

$$\text{Total office CCS} = \frac{\text{TCPC}}{\text{SCPC}} \times \text{SU} + \text{DJ CCS}$$

$$= \text{T/S ratio} \times \text{SU} + \text{DJ CCS}$$

$$\text{T/S ratio} = \frac{12703}{3282} = 3.9$$

$$\text{Total office CCS} = 3.9 \times 6293 + 29082 = 53625$$

$$\text{Average actual load (AL)} = \frac{\text{Total CCS}}{\text{No. of HGs}} = \frac{53625}{400} = 134 \text{ CCS}$$

Step 3:

$$\text{Percentage of capacity} = \frac{\text{AL}}{\text{EL}} \times 100 = \frac{134}{144} \times 100 = 93.05\%$$

Rounded to the nearest whole number (integer) 93.05 percent would be ***93 percent.***

2.33 The QCL tables also require the use of average holding time (AHTs) of the calls creating usage on line equipment. Documentation of the AHT in a traffic unit is necessary for each balance study, by loading division if possible, in order to get the most accurate results. However, where this procedure is impossible or uneconomical to implement, one of the following methods (listed preferentially) may be employed:

(a) Use an AHT for a BH in the most recent available week.

(b) As a last resort, and only in cases where data are unavailable, use 200 seconds as an AHT.

(c) In method (a) where AHT for the loading divisions cannot be established separately, use the AHT for the entire traffic unit. Procedures for approximating AHTs by loading division will be discussed in 3.45 through 3.65.

2.34 Computation of AHT in seconds for a No. 1 Crossbar office is as follows:

$$\text{AHT} = \frac{\text{Total Office CCS} \times 100}{\underset{\text{(all classes of service)}}{\text{DJPC}} + \underset{\text{(all TMGs)}}{\text{TCPC}}}$$

Example:

$$\text{AHT} = \frac{53625 \times 100}{15093 + 12703}$$

$$\text{AHT} = 193 \text{ seconds}$$

AHT = 193 seconds.

2.35 Following, is an example of selecting the QCL percent with the results in 2.32 and 2.34.

Step 1: Given 93 percent of capacity in 2.32, select the table of Fig. 1, page 2, entitled 86 to 95 percent.

Step 2: Given 1440 CCS per LLF in 2.32, select the proper column, 1300 through 1459, of the table found in Step 1.

Step 3: Given a 193-second holding time from 2.34, select the proper range, 191 to 210 AHT.

Step 4: Where the line chosen in Step 3 intersects the column designated in Step 2, the QCL is found equal to ***36*** percent.

2.36 For 10-hour QCLs not represented by tables, please have your company staff contact AT&T Network Administration Group.

2.37 The quality control limit tables in Fig. 1 were constructed using 10 hours of data for a base. These tables are the ***only system tables*** allowed for computing the load balance index as described in DFMP, Division A, Section 5b. It is recommended that 10 hours of data be used for all balance procedures whenever possible. In those cases where this is not possible, an adjustment for the number of hours may be made on any studies ***not*** used for the load balance index. This adjustment corrects the QCL for the lesser reliability of smaller sessions and is calculated as follows:

$$Q = \sqrt{\frac{10}{N}} \times \text{TABLE QCL VALUE}$$

Where:

Q = the new QCL
N = the number of hours of the study

The value of the square root sign may be determined from the following table. This answer can then be multiplied by the table QCL value (Fig. 1) to determine Q.

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 = 48 percent
— N = 8 hours

$$Q = \sqrt{\frac{10}{8}} \times 48.0 \text{ percent}$$

$$= 1.12 \times 48.0$$

$$Q = 53.7 \text{ percent}$$

Note: This procedure may not be applied to studies used for the LBI.

2.38 After computing the QCL as described in the preceding paragraphs, it is possible to establish CCS values for the ±3 sigma points. It is also necessary to indicate load units which are approaching these limits. This is established by designating intermediate points at ±1.5 sigma.

Example:

Assume average usage per load unit in a loading division is 200 CCS and the QCL is 44 percent.

200 CCS x .44 = 88 CCS

+3.0 SD = 200 CCS + 88 CCS = 288 CCS

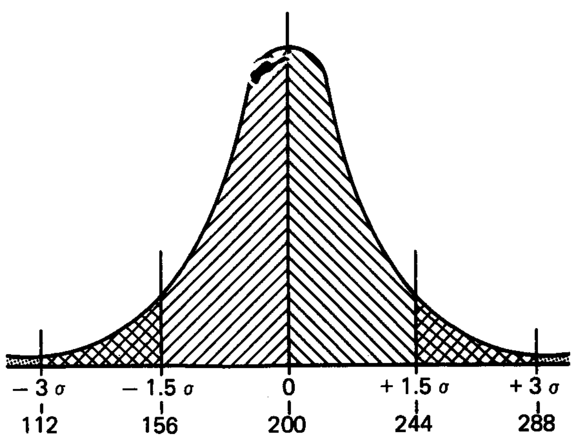
-3.0 SD = 200 CCS - 88 CCS = 112 CCS

+1.5 SD = 200 CCS + 44 CCS = 244 CCS

-1.5 SD = 200 CCS - 44 CCS = 156 CCS

This is illustrated in the distribution curve which follows.

CCS Values . . .



2.39 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 mathematics becomes too complicated to utilize on a manual basis. This deficiency is overcome through the use of an alternate method called the score system.

DEVELOPMENT OF SCORES

2.40 The score system has been developed to simplify the mathematics 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 each load unit has departed from the horizontal group average during a measurement period. In application, all horizontal groups exceeding the QCL on a weekly record are assumed to be out of balance. The other horizontal groups, however, also deviate to a lesser degree above and below the average.

2.41 The procedure for deriving scores is to take the QCL percentage as determined from the preceding paragraphs and apply it as follows.

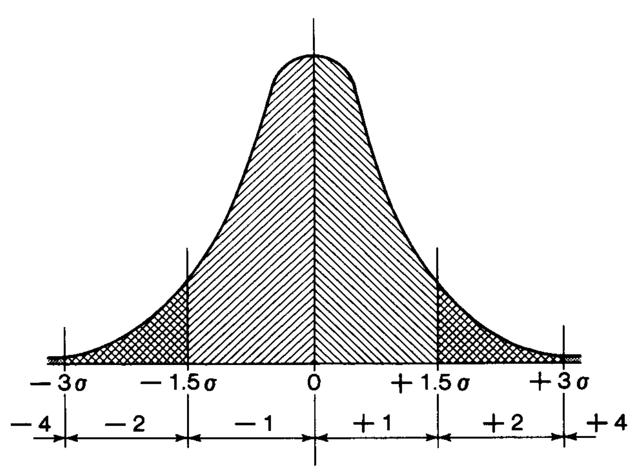
(a) Each load unit with ***exactly average*** CCS is assigned a score of 0 (zero).

(b) Each load unit deviating above or below average, up to and including 1.5 standard deviations (one-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 and up to and including 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 four is used rather than three in order to accentuate this undesirable deviation (see distribution curve below).

Score Method . . .



Example:

Assume average usage per load unit in a loading division is 200 CCS and the QCL is 44 percent. A total of 3.0 standard deviations is 44 percent and 1.5 standard deviations are 22 percent. Scores are computed as follows:

LOAD UNIT CCS	SCORE
289 and higher	+4
245 through 288	+2
201 through 244	+1
200	0
156 through 199	-1
112 through 155	-2
111 and lower	-4

3. SWITCHING SYSTEM BALANCE CONSIDERATIONS

PURPOSE

3.01 This part of this section is intended to give a brief description of the No. 1 Crossbar load unit, point out some loading restrictions, and provide administrative guidance to effect the best possible balance.

TRAFFIC UNIT CONFIGURATION

3.02 The line link frame (LLF) serves as a location for each customer's line for the purpose of originating and terminating calls. It consists of variable amounts of primary switches and ten secondary switches. Subscribers lines are connected to the verticals of the primary switches.

3.03 The basic LLF has 20 verticals located in each of ***ten horizontal groups*** (one vertical is usually used for "no test") and is designated a 190 size. The size of the LLFs may be increased from the basic 190 size in increments of 100 or 200 line switches to the largest or the 590 size LLF. (Earlier No. 1 Crossbar installations may have 690 size LLFs and primary switches with less than 10 verticals.)

3.04 The horizontal group (HG) is the principal equipment requiring load balancing in a No. 1 Crossbar traffic unit.

3.05 The 10 line links or channels, as they are sometimes called, of a HG are common to all customers in that group. In the 190 size LLF, up to 19 lines share the 10 channels and in a 590 size LLF, a maximum of 59 lines can share these 10 channels for originating and terminating calls.

3.06 The HGs on a LLF are subject to a controllable load. The effective balance of HGs, within established control limits, should produce proper balance among the frames of any given loading division and provide a uniform grade of service to all customers.

3.07 Detailed information about the LLF and its component parts may be found in the TFP, Division D, Section 2b-1. A No. 1 Crossbar System description may be found in Bell System Practices Section 816-000-000.

FEATURE RESTRICTIONS

3.08 Line link frame size and service features must be considered when balancing a No. 1 Crossbar traffic unit. Line link frame size is engineered in accordance with average customer usage requirements (CCS/MS). Service features are required for proper customer calling treatment.

3.09 The LLFs are arranged to provide for unique processing of customer originated calls in accordance with their routing, charging and calling privileges.

3.10 A maximum of 24 classes of service may be assigned in a No. 1 Crossbar originating marker group. This quantity is based on current design limitations of the subscriber senders and originating markers. Coin and noncoin classes are not intermixed on No. 1 Crossbar LLFs. Each noncoin LLF can serve a maximum of six classes of service and each coin LLF is limited to three classes of service.

3.11 The types of LLFs and some examples of the classes of service that can be handled on each type of frame are as follows:

Three-wire frame—coin (tip, ring, sleeve)

Individual semi-public (ISP)
Individual public (IPT)

*Three-Wire frame—flat rate and local automatic message accounting service (tip, ring, sleeve)

Unlimited (1R)(2R)(4R)(8R)
Individual extended area (1ER)
Unlimited suburban (1SR)(2SR)
Individual business (1B)
Unlimited PBX (PBX)

*Four-wire frame—individual and PBX message rate service (tip, ring, sleeve and meter)

Individual measured residence (1MR)
Individual measured business (1MB)
Measured business PBX (MPBX)
Measured business PBX—toll denial (MPBX-TD)
Measured residence PBX (RPBX)

*Five-wire frame—two party message rate service (tip, ring, sleeve, meter one, meter two)

Two party measured residence (2MR)
Two party measured business (2MB)

*(maximum—6 classes)

3.12 The class of service indication given by a LLF is determined by the location of the vertical on the LLF primary switch to which the calling line is assigned. The ten verticals located one above another on the primary switches of a LLF bay comprise what is called a ***vertical file.*** The verticals on a LLF are grouped into columns. Each column consists of ten vertical files, numbered 0 through 9 from left to right. The number of columns per LLF is determined by LLF size. Because the first vertical file on the LLF is normally required for a maintenance feature called "no test," the number of vertical files in that column to which customers can be assigned will be nine. All other columns will have ten vertical files for customer lines.

3.13 The class-of-service in a No. 1 Crossbar traffic unit is fixed by vertical file. Like-numbered vertical files in all columns of a standard LLF are normally restricted to the same class of service.

3.14 ***Class of Service Identification by Individual Vertical File:*** Class-of-service assignment restrictions by column can be circumvented with a minor LLF modification. This modification provides a class of service indication by individual column and vertical file and requires the addition of a relay and ten punchings per column. Each column modified in this respect can have from one up to six of its vertical files assigned different classes of service than the like numbered vertical files in the other columns of the LLF. Other columns of this LLF or other LLFs in the unit may be modified to the extent of the requirement for individual file class of service (still within the limit of six ***(maximum)*** per LLF).

3.15 ***Multiple Size LLFs:*** A number of Bell System No. 1 Crossbar traffic units have multiple size LLFs. They are usually installed in this manner because of capital budget constraints and cause administrative problems because smaller frames are limited in the number of lines they can terminate. Consequently, separate loading divisions may be necessary to allow each size LLF to be loaded differently. In addition, traffic measurements are unavailable to determine specific load and service characteristics by loading division.

3.16 ***TOUCH-TONE:*** If a No. 1 Crossbar traffic unit is to be equipped for 100 percent TOUCH-TONE, all subscriber senders are modified. However, if a smaller number of TOUCH-TONE main station is forecasted and it is decided not to modify all subscriber senders, a modification of the LLFs can designate certain horizontal groups for this type of service.

3.17 The LLF modification provides for differentiation between combination TOUCH-TONE/rotary dial and rotary dial only customers by horizontal group. Each horizontal group must be arranged to indicate whether or not it requires a combination TOUCH-TONE/rotary dial or a rotary dial only subscriber sender subgroup.

3.18 In general, selection of the same horizontal groups on each frame will facilitate assignment administration, but any horizontal group may be selected if, for some reason, this appears desirable. The cross connection of a horizontal group for rotary dial or TOUCH-TONE is about the same as a class-of-service change, and can be handled on the same basis.

3.19 ***Dial Tone First:*** The dial tone first (DTF) service provides dial tone to certain coin stations without requiring an initial coin deposit. Since arrangement of a No. 1 Crossbar traffic unit for DTF service involves extensive subscriber sender changes, only the quantity of subscriber senders required for service are modified.

3.20 A partial conversion of subscriber senders requires a coin LLF modification for differentiation by horizontal group. This modification utilizes the same circuitry as required for a partial TOUCH-TONE conversion and directs each coin line to either a DTF or regular subscriber sender subgroup. If the unit is operating on the basis of a partial TOUCH-TONE conversion, then all the TOUCH-TONE/rotary dial combination senders require modification for DTF operation. This is necessary so that the same horizontal group steering circuitry can provide sender subgroup discrimination for DTF lines as well as for TOUCH-TONE lines.

3.21 ***Line Link Pulsing:*** Line link pulsing (LLP) is a method used to provide direct-in-dialing (DID) to centrex (CU) customers by outpulsing the extension number over a common private branch exchange (PBX) trunk group. A feature normally utilized with LLP arrangements is the individual vertical file identification which permits as few as ten line equipments on a LLF for LLP class of service.

LOAD BALANCE

3.22 This part provides guidance to effect good load balance and to minimize problems associated with feature restrictions shown in 3.08 through 3.21.

3.23 The best possible balance that can be achieved in a traffic unit is established by spreading each category, such as class-of-service and rate zones, equally across all LLFs. In traffic units without serious restrictions and enough demand, this approach is feasible. Where feature restrictions are major and demand is small, some equitable manner must be devised to assign lines over as many frames as possible. These procedures will be discussed further in other paragraphs of this section. Once a proper spread is established, usage measurements should be used to ***fine tune*** these assignments.

3.24 ***Loading Plans:*** A loading plan, as previously stated in 2.09, is the key for achieving good load balance. This plan is one that improves balance at each opportunity and assures optimum balance during peak loads. It recognizes that, as engineered capacities are reached or exceeded, intensified administrative attention is needed to assure that service goals will be met. Good loading plans maintain balance between traffic units in a wire center and wire centers which serve the same geographical area.

3.25 A loading plan is developed by the network administrator using three major sources of information: official documentation, historical data, expected office usage characteristics, plus coordination with the network design engineer. Each of the three sources must be molded together to create a unique comprehensive and effective plan.

3.26 Official documentation includes the following:

(a) ***Commercial Forecast:*** This provides the expected growth by class of service.

(b) ***Equipment Order:*** Equipment order provides the information regarding installed equipment, engineered capacities (including trended data) by component, trunk and service circuits.

(c) ***Demand and Facility Chart:*** This chart provides a pictorial representation of items (a) and (b). Indicates dates for job exhaust.

3.27 Historical data should be analyzed for developing trend information and to assist in making realistic decisions about CCS/MS by class of service, expected in-and-out movement, calling rates and service levels, etc.

3.28 Each traffic unit has its own unique characteristics which should be identified for loading purposes. Calling rates, holding times, in-and-out movement, class-of-service mix are affected by community items such as seasonal business, conventions, college activities, planned retirement communities, etc.

3.29 Coordination with the network design engineer is very important. The engineer has designed the entity based upon some basic traffic assumptions and historical data. The traffic unit has to be administered and loaded with this information in mind. It is recommended that prior to each job and every busy season the basic data design values, originating and terminating busy hour calls and traffic trends should be mutually discussed and agreed upon. If the calling characteristics or class-of-service mix should change during the year, the network administrator should inform the network design engineer. Any major changes in a traffic unit characteristics should be reflected in the loading plan.

3.30 The loading plan should be developed for the year, broken down by month, for each major class of service. Utilizing the information derived from the three basic sources, the plan should state the expected monthly main station (ms) gain or loss and be compared to the actual monthly growth.

3.31 Once the plan is developed, loading priorities must be developed to assist in the day-to-day assignment job. Horizontal groups may be identified within each LLF over which to equitably spread the usage (classes of service). The identification process must be tempered with judgment. Assignment considerations should include identifying those classes of service with heavy loads, such as centrex (CU) and PBX lines. Special care should be taken to distribute high call volume customers such as outward wide area telephone service (WATS), inward WATS, and data ports.

3.32 If long range forecasts predict a drastic shift in class-of-service mix, loading plans should consider methods for efficiently managing such a change.

3.33 Once the loading priorities have been established, consideration should be given to the line assignments advanced to the assignment bureau. Assignments previously advanced to the assignment bureau which no longer meet balance requirements based on new load balance data, should be recovered.

3.34 ***Multiple Size LLFs:*** The multiple size LLF traffic units loaded to a low percent of line fill can achieve an equal spread of lines and maintain one loading division by considering all LLFs as having no more line relays than the smallest LLF, eg, in a unit with ten 490s and four 590s, all 14 frames are considered as being the 490 size. This is the preferred method from an administration point-of-view.

3.35 This multiple size LLF operation should be avoided and whenever possible, eliminated on the next addition. However, when additions are not contemplated and there is a high line fill, the approach of 3.34 may prove to be impractical. An extreme procedure to compensate for this problem is to assign heavy usage lines to the smaller frames and light usage lines to the larger frames. In this manner it is possible to allow each frame to carry the same load (CCS/LLF). Unfortunately, this method may cause a division between classes of service and create ***stranded capacity.*** The following example will illustrate why stranded capacity is possible:

Given:

Line Link Frames — 20-390 and 20-490

	CBH CS1	CBH CS2	OBH
	10:30—11:30	7:30—8:30	3:30—4:30
Total CCS	36000	36000	40000
Contribution			
CS1	28000	8000	20000
CS2	8000	28000	20000
CCS/LLF			
CS1	1400—	400	1000
CS2	400	1400—	1000
Office	600+	600+	1000

In this example if the LLFs were designed at 1000 CCS/LLF for the busy hour, service during the class-of-service busy hours will be above objective for at least one-half of the frames.

3.36 Another approach to loading different size LLFs is to establish a higher percent fill in the smaller frames to effect a more even distribution of classes of service. Figure 2 is an example of the procedure used for a traffic unit in one of the operating companies. Form E-6618 should be used for these computations. Instructions for preparation of Form E-6618 and a completed form are shown in Fig. 2.

3.37 Basically, the method is to establish minimum requirements for high usage lines, such as business, and attempts to load the traffic unit in that direction. Load, numbers, and frame limitations must always be taken into account when devising a plan for working traffic units. In addition, where main stations are working, attempt to minimize moves by judicious selection.

3.38 ***TOUCH-TONE:*** No. 1 Crossbar traffic units completely modified for TOUCH-TONE operation are easily maintained from an administrative point of view. New TOUCH-TONE lines are simply distributed across as many HGs and LLFs as possible. When there is a partial conversion, administrative problems begin to appear, especially if there is a high TOUCH-TONE development.

3.39 In offices with a partial TOUCH-TONE conversion, it may be desirable to modify an equal number of HGs in each LLF to minimize administrative difficulties.

3.40 When the unit is converted initially, extra senders should be provided to care for higher holding time dial pulse (DP) customers working on TOUCH-TONE HGs. Later advantage can be taken of this situation by allowing some DP lines to continue to work in these HGs. Thus, a better mix of customers will result and lessen the need for separate loading divisions.

3.41 Separate loading divisions should be avoided unless it can be shown that the characteristics of DP and TOUCH-TONE HGs are substantially different. The value of separate loading divisions will be offset by the fact that holding times will not be available.

3.42 Factors to be considered between a partial and complete conversion are: estimated growth, amount of originating equipment to be converted, number of lines to be relocated in providing HG segregation and additional equipment required for split group operation.

3.43 From a network administration point-of-view, a traffic unit should be completely modified. Furthermore, in units with large TOUCH-TONE developments the possibility of complete modification should be explored.

3.44 The network administrator should provide the network design engineer with as much information as possible in order to make an intelligent decision. The items outlined in 3.42 should also be considered when making modifications.

SPECIAL QUALITY CONTROL LIMITS DETERMINATION

3.45 This part provides guidelines to establish quality control limits (QCLs) in traffic units having ***multiple loading divisions.***

3.46 Multiple loading divisions are not recommended unless one or more of the following items has a significant impact on the QCLs developed. They are:

(a) Loading (percentage of capacity)

(b) Class of service (coin and noncoin)

(c) Size LLFs

(d) Rate zones.

3.47 Terminating marker groups (TMGs) within one originating marker group (OMG) are separate loading divisions by definition (see 2.03), ie, telephone number changes would be required to effect load balance between TMGs. Even within a TMG differences may exist that require separate loading divisions, ie, coin and noncoin LLFs.

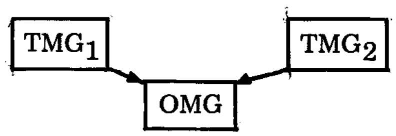
3.48 Since there are no standard measurements to determine individual loads carried in traffic units with multiple loading divisions, an approximate approach may be used whereby AHT and percentage of capacity for each loading division is calculated. In calculating percentage of capacity and AHT within a TMG it is assumed that only two classes of service exist (coin and noncoin).

3.49 No. 1 Crossbar traffic units may be installed in one of several different basic configurations, as follows:

	OMG	TMG
(a)	Single	Single
(b)	Single	Multiple
(c)	Multiple	Multiple

3.50 The general formula shown in 2.34 would be used for configuration (a) in the above example. It can also be used for (b) with modification and the assumption that each traffic unit has 50 percent terminating traffic (noncoin), each has similar characteristics and if a TMG has a coin loading division the ***terminating traffic to coin lines is not a factor.***

3.51 Total usage is established for the combined TMG in this manner:



$$\text{Total CCS} = (\text{ILF SU} \times \text{T/S})_{\text{TMG}_1} + (\text{ILF SU} \times \text{T/S})_{\text{TMG}_2} + \text{DJU (noncoin)}$$

3.52 The percentage of capacity is calculated for the combined TMGs (noncoin) as follows:

$$\text{Average actual load} = \frac{\text{Total CCS}}{\text{Number of HGs (noncoin)}\ \text{TMG}_1 + \text{TMG}_2}$$

$$\text{Percent of capacity} = \frac{\text{AL}}{\text{EL}} \times 100$$

3.53 The AHT for the combined TMGs (noncoin) is computed in this manner:

$$\text{AHT} = \frac{\text{Total CCS} \times 100}{\text{DJPC + TCPC (total channel peg count) (noncoin)}\ \text{TMG}_1 + \text{TMG}_2}$$

3.54 The approximate average load and percentage of capacity for a coin loading division can be established in the following manner:

$$\text{Average actual load} = \frac{\text{DJU (coin)}}{\text{Number of HGs (coin)}}$$

$$\text{Percentage of capacity} = \frac{\text{AL}}{\text{EL}} \times 100$$

3.55 The approximate holding time for a coin loading division is computed as follows:

$$\text{AHT} = \frac{\text{DJU (coin)}}{\text{DJPC (coin)}}$$

3.56 If coin line junctors (LJs) are wired to the TUR then the average actual load and percentage of capacity is computed in the following manner:

$$\text{Average actual load} = \frac{\text{DJU (coin) + CN LJU}}{\text{Number of HGs (coin)}}$$

$$\text{Percentage of capacity} = \frac{\text{AL}}{\text{EL}} \times 100$$

> ***Note:*** The approximate holding time can be computed as in 3.55. If LLF terminating peg count is available, then the holding time can be computed as follows:

$$\text{AHT} = \frac{\text{DJU (coin) + CN LJU}}{\text{DJPC (coin) + LLF TPC (coin)}}$$

3.57 If the characteristics are significantly different or the percent terminating is ***not*** 50 percent, the calculations are made using the percent sample originating (PSO) factor. The PSO is developed for each TMG as follows:

$$\text{PSO}_{\text{TMG}_1} = \frac{(\text{LLF SU} - \text{ILF SU})_{\text{TMG}_1}}{(\text{LLF SU} - \text{ILF SU})_{\text{TMG}_1} + (\text{LLF SU} - \text{ILF SU})_{\text{TMG}_2}}$$

3.58 Total usage is developed for each TMG as follows:

$$\text{Total CCS}_{\text{TMG}_1} = \text{ILF SU}_{\text{TMG}_1} \times \text{T/S} + \text{DJU (PSO)}_{\text{TMG}_1}$$

3.59 The percentage of capacity is calculated for each TMG in this manner:

$$\text{Average actual load}_{TMG_1} = \frac{\text{Total CCS}_{TMG_1}}{\text{Number of HGs}_{TMG_1}}$$

$$\text{Percentage of capacity}_{TMG_1} = \frac{\text{AL } TMG_1}{\text{EL } TMG_1} \times 100$$

3.60 AHT for each TMG is computed as follows:

$$\text{AHT}_{TMG_1} = \frac{\text{Total CCS}_{TMG_1}}{\text{DJPC (noncoin)} \quad (\text{PSO})_{TMG_1}} \times 100$$

3.61 Configuration (c) represents a nonstandard arrangement and requires several calculations to develop capacity percentages and actual holding time. See Fig. 3 for an example of the calculations necessary for this type of configuration.

3.62 Knowledge of the percentages of capacity and AHTs will provide the information for selection of the proper QCL in Fig. 1.

3.63 When multiple size LLFs exist within a loading division and the approaches to loading different size LLFs described in 3.34, 3.36, and 3.37 do not prove practicable, ie, characteristics are different, it may be necessary to create separate loading divisions.

3.64 Following is an example of a method used to approximate the load carried in a noncoin TMG having two different size LLFs.

Parameters:

Total LLFs = 40
LLFs-LDa = 20 LLFs 290 Size
LLFs-LDb = 20 LLFs 490 size
Theoretical capacity = 1160 CCS/LLF

Step 1: Establish Grouping Line

Ro = T/S ratio for all of the LLFs

SUo = Average sample usage for all of the LLFs

Given:

$$\text{Ro} = 3.88 \text{ SUo} = \frac{10800}{40\text{LLF}} = 270 \text{ SUo}$$

These values are plotted on the chart in Fig. 4. A line is then drawn through this plot point parallel to the given line. This becomes the characteristic line for all of the LLFs.

Step 2: T/S Ratio and CCS/LLF-LDa (290 size LLFs)

Plot the average sample usage for LDa (290 size LLFs) along the grouping line. At this point read across to the vertical for a proper T/S ratio.

Given:

$$\text{SUa} = \frac{5600}{20\text{LLF}} = 280 \text{ SUa}$$

Find: T/S ratio (Ra) = 3.98
Calculate: Ra × SUa = CCS/LLFa
3.98 × 280 = 1114

Step 3: Percentage of Capacity - LDa

$$\text{Percentage of capacity} = \frac{\text{CCS/LLFa}}{\text{Theoretical Capacity}} \times 100$$

$$= \frac{1114}{1160} \times 100 = 96\%$$

Step 4: AHT - LDa

Given: Ro = 3.88 Ra = 3.98
LLFo = 40 LLFa = 20
Sample PC Total Office (SPCo) = 8999

Calculate:

$$SPCa = \frac{Ra}{Ro} \times SPCo \times \frac{LLFa}{LLFo}$$

$$SPCa = \frac{3.98}{3.88} \times 8999 \times \frac{20}{40}$$

$$= 4615$$

$$AHTa = \frac{SU\ LDa}{SPCa} \times 100$$

$$= \frac{5600}{4615} \times 100$$

= 121 seconds

Step 5: T/S Ratio and CCS/LLF - LDb (490 size LLFs)

Plot the average sample usage for LDb (SUb) along the grouping line.

Given:

$$SUb = \frac{5200}{20LLF} = 260\ SUb$$

Find: T/S Ratio (Rb) = 3.78
Calculate: Rb × SUb = CCS/LLFb
3.78 × 260 = 985

Step 6: Percentage of Capacity - LDb

$$\text{Percentage of capacity} = \frac{CCS/LLFb}{\text{Theoretical Capacity}} \times 100$$

$$= \frac{985}{1160} \times 100 = 84.9\%$$

Step 7: AHT - LDb

Given: Ro = 3.88 Rb = 3.78
LLFo = 40 LLFb = 20
SPCo = 8999

$$SPCb = \frac{Rb}{Ro} \times SPCo \times \frac{LLFb}{LLFo}$$

$$= \frac{3.78}{3.88} \times 8999 \times \frac{20}{40}$$

$$= 4384$$

$$AHTb = \frac{SU\ LDb}{SPCb} \times 100$$

$$= \frac{5200}{4384} \times 100$$

= 119 seconds

3.65 Develop QCLs for each loading division.

	% CAP	AHT	QCL
LDa	96	121	28
LDb	86	119	31

Since each group of different size LLFs have a different QCL, separate loading divisions should be established. When calculations of percentage of capacity and AHT indicate that both groups have the same QCL and characteristic, combine them into one loading division.

LOAD BALANCE WITHOUT USAGE MEASURING DEVICES

3.66 This part provides guidelines to follow in traffic units without usage measuring devices installed, full access to existing measurement equipment or inoperative devices.

3.67 As stated in 3.23, the best possible balance that can be achieved in a traffic unit is established by spreading each category, such as class of service and rate zones, across all LLFs for the loading division.

3.68 Feature restrictions must be accounted for, and a proper spread then accomplished within these limitations.

3.69 Fine tuning, which is normally provided by the interpretation of usage data, cannot be developed in the same manner. Instead, this fine tuning is dependent upon interpretation of data recorded from various traffic registers and special studies. Since these data do not have the characteristics of precise load indications, the good judgment of the network administrator is a most important factor in maintaining adequate balance.

3.70 ***Traffic Registers and Special Studies:*** Measuring devices are available eg, portable traffic usage recorder (TUR) for special study purposes. However, they are limited by the amount of items that can be studied at any given time due to machine limitations.

3.71 If a modified line insulation test (LIT) frame is available, various traffic counts can be taken which include the following.

(a) Line link office count (LLOC) provides usage for all line links in the traffic unit. The LLOC feature makes a busy test every 3 minutes on all links (channels) in every line link frame. It starts counting in horizontal group "0" in each frame and progresses through horizontal group "9". The busy links found are scored on the busy link registers.

(b) Line link horizontal count (LLHC) provides the usage per horizontal group for one frame at a time. Results obtained are used to determine the light and heavy horizontal groups within a frame.

3.72 When it has been determined that a frame is out of balance in relationship to the other frames in the office, a LLHC can be taken to pinpoint the heavy and light horizontal groups in the frame.

3.73 In addition to the above, or if they are not available, there are some other indicators that could aid in effecting proper load balance.

(a) ***Line Link Frame Load Register:*** There is one register per LLF and operates whenever an incoming call to an idle line in any horizontal line group on the frame finds a specified number of line links busy serving the horizontal line group.

Note: The busy line link measurement can be varied to produce different results.

(b) ***Horizontal Line Groups:*** There are 10 registers for 40 line link frames. The registers may be associated with any one of the line link frames for each horizontal line group. Each register operates whenever, an incoming call to an idle line in its associated horizontal line group finds a specified number of the line links busy in the associated horizontal line group.

3.74 A computer printout (CTRAP) is available from the maintenance service center which compiles all customer reports including code 5 (central office trouble), code 7 (no trouble found outside), and code 8 (no trouble found inside). Analyzing this printout with the various customer reports as back-up may indicate an imbalance if it is determined that the reports are generated from a particular horizontal group or from a particular class of service.

MAIN DISTRIBUTING FRAMES

3.75 This part provides basic information with regard to the main distributing frame (MDF) and its impact upon traffic unit balance.

3.76 The MDF provides a means of flexible assignment of cable pairs to trunks and line equipments. Line equipments may be assigned on a completely random basis or administered to minimize cross-connection (jumper) lengths.

3.77 Random assignment of lines is unsatisfactory because it tends to increase jumper lengths and congest frame levels, shelves, or troughs. COSMIC frames are particularly subject to congestion if short jumpers are not utilized.

3.78 The initial layout of an MDF and subsequent additions of cables and line equipments should be planned for optimum use of the opportunities for short jumpers without sacrificing good load balance procedures. The amount of interdepartmental planning required will vary with the type of MDF and the nature or size of the community being served. MDFs with a high service order activity and serving several switching entities must be designed and administered with extreme care.

3.79 The network administrator should establish appropriate interdepartmental and intradepartmental contacts to ensure that loading considerations are included in the decision-making process for locating cables and line equipments. Network administrators must be familiar with their MDF layouts so that they can participate effectively in the planning process.

3.80 It is generally agreed that a well-engineered layout of cable pairs and line equipment, together with reasonable preferential assignment procedures, can accomplish the optimal short jumper design. In order to accomplish this goal, ongoing interdepartmental coordination is required revolving around a long-range plan. Strict preferential assignment and administrative procedures must be established and maintained interdepartmentally and intradepartmentally. Constant analysis is required to ensure that procedures are achieving the maximum utilization of short jumpers and the goal of good load balance.

3.81 One of the main sources of long jumpers on the MDF comes from cable transfer activity. Either before or after the completion of cable transfers, line equipment transfers (LETs) should be coordinated and prepared to change long jumpers to short jumpers. "T" and "F" service orders within the same wire center where dual service is not involved should be assigned a new equipment that will result in a short jumper.

3.82 ***Conventional Frames:*** The ***conventional MDF*** contains two major components. A ***vertical*** side is used for terminating outside plant cable pairs and a ***horizontal*** side (composed of shelves) is used for terminating line equipment and (where appropriate) directory numbers.

3.83 Conventional MDFs can be constructed in lengths up to several hundred verticals. They are therefore susceptible to long jumper problems. In order to control the lengths of these jumpers, large MDFs are segregated into assignment ***zones.*** These zones are the preferred areas of assignment for selected quantities of cable and central office line equipment. Because of variations in design and layout of equipment on frames, zones must be established locally within each central office.

3.84 Establishing zones will be the joint responsibility of network and frame administrators. The number of zones established on a frame should be the minimum required to control jumper buildup on the horizontal shelves. For further information regarding this subject, refer to Bell System Practices Section 680-830-010.

3.85 In addition to frame zoning, a reduction in jumper buildup and adherence to good loading policies can be effected by:

(a) Spreading cable complements across several verticals, and

(b) In multientity buildings, each entity should be located on a different shelf, one above the other.

3.86 Success with a zoned MDF requires that line equipments be made available in all zones as required to meet inward movement. If, however, this conflicts with loading plans for the building, service objectives will take precedence over MDF considerations.

3.87 ***COSMIC Frame:*** The common systems main interconnecting (COSMIC) frame is a main distributing frame which terminates exchange cables and tie cables. It is associated with No. 1 ESS, No. 1 and No. 5 Crossbar, and Step-by-Step line equipment.

3.88 The COSMIC frame lineup consists of alternating modules of line equipment and exchange feeder cable pairs. Each module has 11 shelves which provide each feeder cable pair access, with a short jumper, to line equipment modules located immediately to the left and right.

3.89 Each module has an upper and lower express trough for routing long jumpers and a large vertical trough between modules for routing short jumpers. A COSMIC frame short jumper is defined as that jumper which does not route via the upper or lower express troughs when making connections of line equipments with an exchange feeder cable pair.

3.90 Incorporated with the COSMIC frame system is a mechanized Program for Arrangement of Cables and Equipment (PACE) which provides an efficient and consistent layout of exchange feeder cable pairs, line equipment, and tie cable pairs.

3.91 The COSMIC frame design depends on preferential assignments which combine load balance and class-of-service requirements with short jumper concepts.

TERMINATING BALANCE

3.92 This part provides general guidance to assist in achieving incoming link frame (ILF) balance and to assist in determining when trunk rearrangements may be required. Previous parts of this section deal with imbalance on the line side of a traffic unit and, because of its importance in providing equal service to all customers, horizontal group (HG) balance is covered in considerable detail. Incoming link frame and switch balance within a unit may also have a significant impact upon service to customers although ILF switches are not associated with any particular group of subscribers. Poor balance results in a loss of ILF capacity and may result in incoming matching loss being experienced by all customers.

3.93 Essentially the concepts that are outlined in Part 2, Principles of Load Balance, of this section are the same for ILFs. ***Loads on ILF switches should be compared to the average and an attempt made to bring all switches to that average.*** However, the QCL tables provided in Fig. 1 of this section ***do not*** apply. Quality control limits for ILF switches have not been developed. It is recommended that individual switch usage be analyzed in relation to design capacity and to the average switch usage in the traffic unit.

3.94 Establishing and maintaining ILF balance is included in the following job functions.

Network Administrator is responsible for overall service in the traffic unit and performs a surveillance role for trunk provision and balance.

Network Design Engineer is responsible for providing enough equipment, both switch and trunk, to maintain service objectives.

Trunk Administrator is responsible for servicing trunk groups to maintain trunk service levels, forecasting future requirements and balancing terminating equipment.

Note: These responsibilities are only shown for their impact upon balance. These job functions may or may not be handled in three separate groups. However, for the purposes of this practice the functions are separated as shown.

3.95 In following the principles of load balance, trunks should be assigned in a manner which will produce a balanced CCS over the load units. A loading plan, jointly developed by the network administrator, trunk administrator and network design engineer, should be established to evenly spread all equipment types for the initial installation and for each subsequent addition of ILFs.

3.96 The pattern of ILF balance in a No. 1 Crossbar traffic unit is, to a great degree, the result of initial trunk equipment arrangements, and assignments. Subsequent trunk additions may not be able to correct errors in the initial phase. The trunk administrator does not have the routine day-to-day control over ILF balance, as is the case with LLFs where there is daily service order activity.

3.97 ***Terminating Group Configuration:*** An incoming link group is made up of three distinct frames: the incoming trunk frame, the terminating sender link frame, and the ILF. The incoming trunk has an appearance on all three frames.

3.98 The ILF provides a talking connection between the trunk and the customer. There are three types of ILFs, each providing different amounts of talking connections namely 100, 120 and 160. The 100-type frame is the original vintage installed in older offices. The 120-type is a modified 100-type. The 160-type is the current standard size ILF. It is possible to have all three types in the same traffic unit.

3.99 As the same number of junctors are provided from each ILF to each pair of LLFs, it is important to maintain an even balance of busy hour incoming traffic among ILFs and among pair of LLFs.

3.100 The number of ILFs per terminating traffic unit is determined by a consideration of the total number of equipped incoming trunks and the total busy hour terminating CCS. A minimum of two ILFs is provided per installation. Heavy traffic loads on the ILFs will increase the percent incoming matching loss beyond the point of satisfactory service.

3.101 ***Balance Procedures:*** It is recommended that an equal number of working trunks (by trunk type) be assigned to each switch to evenly distribute the load. To assist in this distribution process the trunks should be classified as being ***heavy, medium*** or ***light*** trunks by their estimated busy hour CCS load. A ***heavy*** trunk is defined as one having 67 percent or more busy hour usage, a ***medium*** trunk 33 to 67 percent busy hour use, and a ***light*** trunk less than 33 percent busy hour use. (Reference TFP, Division K.)

3.102 The determination of ***heavy, medium*** or ***light*** trunk loads also requires an understanding of how switching machines select trunks. This determination is largely the responsibility of a trunk administrator.

3.103 Incoming trunks to No. 1 Crossbar are not always selected on a random basis at the originating units and must be treated accordingly. The following list provides information about outgoing trunk selection by type of switching system:

SYSTEM	OUTGOING TRUNK SELECTION
Step bv Step (SXS)	Sequential/Random (graded multiple)
Panel	Sequential (graded multiple)
No. 1 Crossbar	Sequential
No. 5 Crossbar	Random
No. 4 Crossbar	Sequential
Crossbar Tandem	Sequential
No. 1 ESS	Random
No. 2 ESS	Random

3.104 Random selection is assumed to impart equal loads to all trunks within a group. Since there is an even distribution, equal numbers of these type trunks should be assigned to each ILF and switch whenever possible.

3.105 Sequentially and graded multiple trunks will carry a heavier CCS load per trunk on the first choices, a lighter CCS load per trunk on the last choices and some intermediate value for trunks selected in the middle of the sequence.

3.106 Relative load carried by each trunk is also determined by the type of trunk group encountered. For example, regardless of how it is selected, ***high usage*** (first route) groups should carry heavier loads per trunk than either ***final*** or ***full*** groups.

3.107 The most appropriate way to balance trunks from other offices, is to spread them over all ILFs, as follows.

(a) Trunks within one group should be evenly distributed over all ILFs to minimize the effects of overloads and directed traffic during emergencies.

(b) Even numbers of heavy, medium and light trunks from each trunk group should be assigned to all ILFs. The most accurate way in which to keep track of the expected load is to assign CCS values to each type of trunk.

3.108 The approaches taken in 3.106 and 3.107 should maximize the chance of success in setting up any network connection, especially those for which retrials are possible, ie, splitting a trunk group among the ILFs will often permit use of a new junctor group for each successive trial.

3.109 The network administrator is responsible for surveillance of trunk load data and provision of these data to the trunk administrator. Usage measurements on each switch are provided.

3.110 Initially, network administrators can compare total LLF usage with the sum of usages for ILFs and district junctors. Any major discrepancy should be analyzed in detail by reviewing each trunk switch individually.

3.111 Another approach is taken by comparing actual trunk switch usage with the appropriate engineering capacity. See example below.

Given:

CCS/Switch = 252 CCS/HR
252 × 10 Hrs. = 2520 CCS

A traffic unit at 50 percent of main station capacity should ***not*** be expected to have ILF switch loads at or near 100 percent of capacity. Traffic units nearing capacity, on the other hand, could be expected to have some load units of this magnitude.

3.112 The most meaningful approach to loading, regardless of the percentage of capacity, is to load toward the best traffic unit average. This average should be weighted over several weeks to be stable. Loading should then be controlled to achieve that average within each ILF switch. Trunks should only be transferred from switches from extremely heavy loads.

3.113 Switch usage data should be used for directing trunk assignments into the least loaded grids. Until standard QCL tables are developed, it is recommended that ±15 percent of the average switch CCS measured in each study be established as the objective range for all switch loads. Assignment of new trunks should be made in the following order of preference. Forms E-6663 and E-6664 are provided for selection of switches on a manual basis. Examples of the completed forms are shown in Fig. 5 and 6.

CHOICE	SWITCHES
First	Below 85 percent of average
Second	Between 85 and 100 percent of average
Third	Between 100 and 115 percent of average
Fourth	Over 115 percent of average

3.114 ILFs that are loaded to a low percentage of capacity (CCS) and not experiencing incoming matching loss (IML) over objective, can tolerate some switch imbalance. Proper assignment procedures should suffice, with expensive trunk transfers minimized or eliminated completely. ILFs that are out of balance will experience some loss in CCS capacity and are subject to IML at a lower percentage of load. Trunk transfers may then be required to increase capacity and reduce the propensity for service deterioration. When a traffic unit is experiencing high IML at a low load level, transfers should be mandatory unless there is some other plan for relief within a short period of time.

3.115 As stated previously, no official QCL tables are available for ILFs. In addition, capacity reduction tables are unavailable and any guidelines at this time would have to be purely arbitrary. It is recommended that each company establish benchmarks for traffic units above 90 percent of capacity. A percentage of groups over 115 percent of the average load should be selected for the guidance of trunk administrators.

3.116 ***Mechanization:*** The business information system—load balance system (BIS-LBS) mechanized program will provide a printout for analysis when deciding where to assign or remove trunks. This printout will provide CCS corrective action to bring individual load units closer to the traffic unit average.

4. DATA CONSIDERATIONS

DATA ACQUISITION

4.01 Load balance data for No. 1 Crossbar traffic units are collected on registers or some mechanized system, such as Engineering Administration Data Acquisition System (EADAS), and processed in a manual or mechanized mode. TURs can provide the data on a daily basis, or through the use of a limited scan feature, on a total week basis. Total week readings reduce the clerical effort required.

4.02 The measurement is a sample (channels 0 and 5) of the total load in a HG. In order to determine the line link frame CCS this value must be multiplied by the total/sample ratio.

4.03 ***Data Collection Frequency:*** Data must be collected and reported once a month for index purposes. It may be collected more frequently for administrative reasons such as when:

(a) The traffic unit is out of balance and the network administrator wants to analyze the results of specific corrective action procedures.

(b) The traffic unit 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 traffic unit is a new installation (at or greater) than 30 percent of capacity) or a growth addition has just been completed, hence a new load balance data base is required. The more quickly the data is collected, the sooner the balance may be analyzed.

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

MISSING OR INCOMPLETE DATA

4.04 Normally, the load balance data are scheduled for collection on a total week basis but it may be appropriate to schedule it daily. Such daily information is desirable as a protection against loss of data due to TUR or mechanization problems. In a register-film environment, this method increases the clerical effort and should be avoided unless absolutely necessary.

4.05 There are circumstances under which the data for the study week may be incomplete as a result of lost or damaged films, etc. The criterion for data reporting in compliance with DFMP, Division A, Section 5b, is that a minimum of 7.1 hours is required, but the full complement of 10 hours is preferable. For administrative purposes, if 6 hours of data are available, there are several ways it can be approached.

(a) Four hours with the same traffic characteristics may be used from the previous collected week within the study month, if available.

(b) The entire 10 hours from a previous study may be used, if available.

(c) As a last resort, as little as 2 hours with the same traffic characteristics from the previous collected study may be used to create an 8-hour study.

If valid data cannot be obtained within the study month, then for index purposes, the data ***are considered not available.*** For administrative purpose the criteria outlined in 2.37 will be followed.

DATA VALIDATION

4.06 The network administrator is responsible for the validation of load balance measurements. Presently there are only a few ways to validate the load balance data. These ways involve visual inspection to determine if the measurements are reasonable.

(a) One method is to compare actual horizontal group usage with the engineered capacity of that horizontal group. The busy hour engineered CCS per horizontal group must be multiplied out to state the 10-hour measurement in order to be comparative. Once the percentage of capacity is calculated (as part of the quality control limits requirements), measurements that are at or exceed capacity should be evaluated as to whether they reflect valid data and/or a load balance problem. The percentage of capacity is relative to the expected load. A traffic unit at 50 percent of capacity should not expect to find horizontal group loads nearing capacity, whereas a traffic unit running at greater than 75 percent of capacity could expect such horizontal group loads. Service indicators associated with traffic unit load balance would be expected infrequently (if the traffic unit is balanced) at 50 percent of capacity and more frequently as capacity is approached.

(b) Another method is that of applying a comparative check of the register readings. A striking change in the percentage would merit investigation of the data (trends, unusual readings, etc), changes in traffic patterns, or comparisons to other data (originating plus terminating, etc).

(c) In the mechanized mode, as should also be done in the manual environment, a validation check will be made to ensure that every register is scoring. A check will also be made to ensure that there are no zero register readings or readings which exceed 2 times 36 times the number of data hours.

REGISTER GROUPING

4.07 Although not desirable, it is possible to effect economics in the provision of traffic registers by installing the register grouping feature. This feature permits using the same traffic registers to record usage, for example, on line link frame horizontal groups during one study period and on incoming link frame switches and the subscribers lines of one or two horizontal groups during another study period. Thus the number of traffic registers that must be provided for load balance can be reduced. Usage data for engineering common control equipment (originating markers, terminating senders, etc) is required on a daily basis, therefore, traffic registers on which such usage is scored are never assigned on a register grouping basis.

4.08 A maximum size No. 1 Crossbar terminating marker group (TMG) has 80 line link frames and 20 incoming link frames and requires 1000 traffic registers exclusively for balancing purposes. At the expense of normally required time-consistent LLF and ILF load balance data collection, register grouping allows a reduction in the required registers to 800 as follows:

PERIOD	ITEMS TO BE MEASURED	NUMBERS OF REGISTERS REQUIRED
1st week	Horizontals for 80 LLFs	800
2nd week	Horizontals for 20 ILFs	200
	Customer lines for 2 horizontal groups	138 maximum

4.09 All equipment in a loading division that is measured for LBI reporting should be arranged to collect data simultaneously. If register grouping does not allow this to be accomplished, then it is not recommended.

4.10 Problems with split loading divisions requiring two weeks of data, may be further compounded because of the lack of a valid side hour. It is entirely possible that a loading division with register grouping may require four weeks of data to be complete. This, of course, is an undesirable situation and should be corrected as soon as possible.

5. BALANCE TECHNIQUES

MANUAL PROCEDURES

5.01 There may be instances where it is necessary to manually compute the load balance scores and an LBI (see Part 6). The clerical effort involved with scoring every load unit individually is time-consuming. It is recommended therefore that these manual calculations be used only when normal computer operations are unable to develop scores and penalty points for an LBI.

5.02 A ***score control record*** (Form E-6615), is used for developing weekly CCS ranges for a loading division, as discussed in 2.40 and 2.41. Instructions for preparation of Form E-6615 and a completed form are shown in Fig. 7.

5.03 A ***load unit—load balance chart*** (Form E-6616) is used to record the load unit weekly scores, penalty points, and hot spot penalty points. Instructions for preparation of Form E-6616 and a completed form are shown in Fig. 8.

5.04 ***Ordering Forms:*** "E" forms (code A) utilized by this section may be ordered from a local Western Electric service center as follows:

ORDER WORDING	ORDERING MULTIPLE
(Qty.) Form E-6615	50 per pad, 2 pads per package; unit 100 forms

MECHANIZED PROCEDURES

5.05 A mechanized method has been prepared to provide procedures for the proper balance and assignment of lines in addition to computing an LBI. This method is called the load balance system (LBS) and is a business information system (BIS) development with full user documentation.

5.06 The user is responsible for providing specific information to the program in order for the necessary calculations to be made. This parameter information includes:

(a) Service observing end-of-month date

(b) Number of data hours

(c) Average holding time (by loading division)

(d) Capacity

(e) Average-office CCS/MS or light office CCS/MS. The determination of these parameters are discussed in 5.29 through 5.36 of this section.

5.07 Once the parameter and usage information have been inputted into the mechanized program, three basic user reports are available in an off-line mode.

(a) ***Index Study—Data Summary:*** This is a working report that allows manual inspection of all load unit data being used for index calculation. Information includes: average hour CCS current study week, balance and hot spot penalty points for the three latest index study weeks.

(b) ***Assignment Guide Report:*** Develops a line assignment guide to be used for line-assigning purposes. The output is discussed in further detail in 5.09 through 5.47 of this section. A removal guide is developed to identify potential line transfers from overloaded HGs. For line assignment purposes, these reports should be requested at least monthly and supplemented with reports as required.

(c) ***Traffic Unit Index Report:*** This report is prepared by loading division and traffic unit everytime an LBI study is taken, and includes load units installed measured and not measured, capacity data, and balance and hot spot penalty points. The contents of this report follow closely the Form E-6402. Index reports are also provided for the company by areas, for divisions by districts, and for districts by traffic units. The contents of these reports follow closely Forms E-6403 and E-6404.

5.08 Flagging capabilities are available for data validation purposes. The system automatically flags HG data that registers:

(a) "0" usage

(b) Usage that exceeds 2 × 36 × number of hours input

(c) As a hot spot following the criterion of 210 times the number of hours.

CORRECTIVE ACTION

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

5.10 The proper corrective action must be established in a specific sequence to be most meaningful.

(a) Review all load balance data. This will indicate load units that are working at exceptionally heavy or light loads.

(b) Review raw data on the load units highlighted in (a). This may prove to be the most valuable step. Errors at this stage will, of course, cause unnecessary or incorrect action.

Note: A TUR detector test will only check leads from the TUR to the registers. A continuity test must be made to check the entire circuit operation.

(c) Assuming that the data are valid, review the required CCS corrective action.

(d) If time and service conditions permit, achieve balance by directed assignments.

(e) If line equipment transfers are required, several indicators should be analyzed to determine the proper lines to move as discussed in 2.16 through 2.18 of this section.

5.11 ***Directed Line Assignments:*** 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 load units and allows disconnects to accumulate in heavily loaded units. This will be discussed in detail beginning with 5.23.

5.12 ***Outward Movement:*** Disconnected lines are another source for maintaining balance among HGs. When lines are disconnected in heavily loaded HGs they serve to equalize the carried CCS among HGs. On the other hand, disconnects in lightly loaded HGs serve to heighten the imbalance. This is discussed in 5.32.

5.13 ***Line Equipment Transfers (LETs):*** LETs can accomplish the same result as directed line assignments. As a matter of fact, this corrective action produces quicker results. However, LETs are expensive to implement and therefore should be the last-choice method of corrective action.

5.14 ***CCS Corrective Action List:*** Regardless of the method employed to achieve balance, an appropriate CCS corrective action must be calculated to determine whether or not that correction is sufficient. The principal guide provided to the administrator for this purpose is called the CCS corrective action list. It is used for determining where to direct assignments and to calculate the number of assignments to be made. This listing is the output of most load balance procedures (both manual and mechanized) and specifies an estimate of the amount of CCS that each load unit is generating above or below the average for the loading division.

5.15 The following paragraphs will advance methods for developing CCS corrective values in load units for manual and mechanized systems and provide two approaches to the development of a CCS corrective action list.

5.16 In viewing some of the difficulties inherent in previous procedures for developing CCS corrective values, it is clear that any new method for computing remedial action should have the following features.

(a) It should be based on CCS measurements rather than scores. Differences in loads, even among HGs with the same scores, could then be detected.

(b) It should be sensitive to usage trends to avoid future overloads.

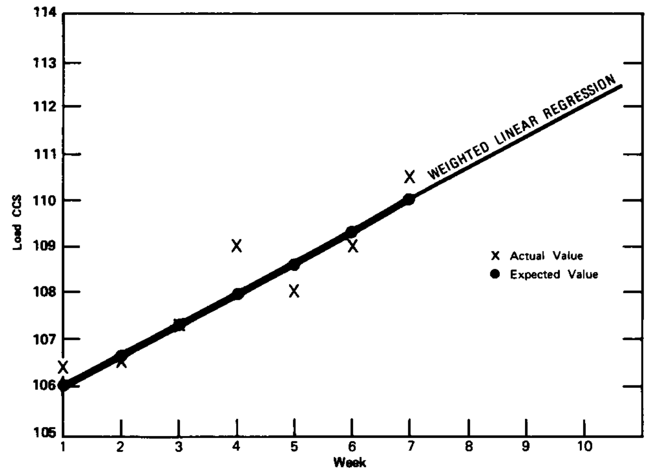
(c) It should apply more weight to recent measurements since they are more representative of the actual load situation.

(d) Finally, it should correct the usage in load units to the average for the loading division to avoid wasteful overcorrection.

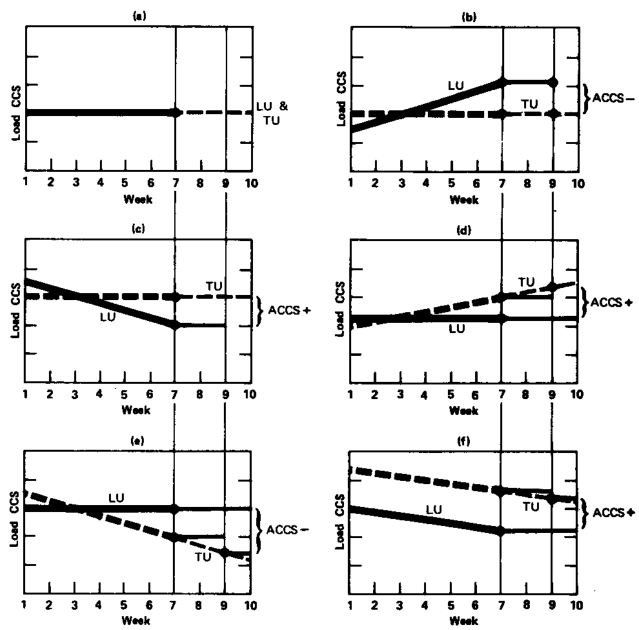
5.17 ***Mechanized Procedure:*** The mechanized data processing procedure developed for the new LBI plan incorporates all four of the desirable features outlined in 5.16.

5.18 Basically, the mechanized procedure takes historical load unit information and utilizes a weighted linear regression to estimate ***expected*** loads on these units (see graph below). It can be seen that weekly loads do not all fall on the ***best fit*** line. The points on the line corresponding to each week are the expected values. Each week is numbered from the oldest (week one) to the newest (week seven).

> ***Note:*** The process is shown for a period of seven weeks. However, this number could differ according to the amount of historical data being saved.



5.19 A similar approach is taken for the average load unit load in the traffic unit. Individual load units are then compared to this traffic unit line to determine the CCS amount to be added or removed (see graphs [a] through [f] which follow).



5.20 CCS corrections are applied to the load units depicted on the graphs in this manner.

(a) None. The load unit and traffic unit average track exactly.

(b) Subtract CCS. The load unit load is increasing and the traffic unit load is constant. The CCS difference for the latest week indicates a need for removal of load. Assuming that action will be taken during week nine, this difference during week seven should be removed. This amount is taken at week seven levels because the load unit line is not as stable as the traffic unit line and should not be extrapolated.

(c) Add CCS. The load unit load is decreasing and the traffic unit load is constant. The CCS difference for the latest week indicates a need for additional load. Assuming that action will be taken during week nine, this difference during week seven should be added.

(d) Add CCS. The traffic unit load is increasing and the load unit load is constant. The CCS difference for the latest week indicates a need for additional load. If action is taken during week nine and the difference during week seven is added, there will be a slight undercorrection. Therefore, an additional amount must be loaded into this unit.

(e) Subtract CCS. The traffic unit load is decreasing and the load unit load is constant. The CCS difference for the latest week indicates a need for less load. If action is taken during week nine and the difference for week seven is subtracted there will be a slight undercorrection. Therefore, an additional amount must be removed from this unit.

(f) Add CCS. Both the load unit and traffic unit loads are decreasing at approximately the same rate. The CCS difference for the latest week indicates a need for additional load. If action is taken during week nine and the difference during week seven is added there will be a slight overcorrection. Therefore, a smaller amount must be loaded into this unit.

5.21 Corrective CCS values developed from the foregoing information cannot be considered exact because of the variable factors involved. Any overestimation in the amount of CCS correction could result in more line moves than necessary to attain balance. These additional moves might have to be compensated for at a later date. Consequently, the computer will scale down all values derived in this manner.

5.22 Any method for scaling the CCS correction to be applied to load units would be fairly arbitrary. The procedure adopted for this practice is to scale the values by a factor based on the variance of the estimated CCS to be added or subtracted. Study results indicate that this procedure produces better load balance than the method used in the previous plan.

5.23 ***Line Assignment Guide:*** The CCS corrective action list, for purposes of this practice, will be referred to as the line assignment guide as it provides information to implement a directed line assignment policy.

5.24 Typically, corrective action lists are provided to the network administrator in an ordered fashion with the units that are most below average presented first. See example which follows.

NO. 1 CROSSBAR
ESTIMATED CCS/MS = 4

LLF	HG	CCS TO ADD	LINES TO ADD
33	5	70	17
26	9	60	15
13	1	54	13
35	2	54	13
6	1	53	13
8	8	50	13
33	7	46	11
28	6	40	10

5.25 This list is not as useful as it might first appear. The network administrator must still determine the order in which these lines should be assigned, what to do if sufficient lines are not available in each group, and how to use disconnect information.

5.26 This part will detail two alternative mechanized procedures which provide the network administrator with some guidance in answering these questions. Moreover, these procedures are features of the new load balance system developed by Bell Laboratories-BIS.

5.27 The first procedure presumes that the traffic unit is predominantly one broad class of service such as residence. This approach should only be taken when any of the following are true:

(a) The deviation from this average CCS per main station (CCS/MS) is minimal.

(b) Subscriber line usage (SLU) studies approximations of CCS/MS for each class of service are unavailable.

(c) There is a need to reduce the length of the line assignment guide (some expertise is required if this procedure is adopted).

5.28 The second procedure should be used when more detail is required, especially when capacity is being approached. It provides a line assignment guide by distinguishing between main stations of three load characteristics: light, medium, and heavy.

5.29 ***Alternative Procedure No. 1:*** The average CCS per main station is estimated by dividing the actual load (CCS) by the number of main stations being handled within the loading division(s). For example let us consider a No. 1 Crossbar unit with 390 size line link frames, an actual load of 1400 CCS/LLF and 350 MS/LLF. The average CCS/MS would be:

$$\text{Average CCS/MS} = \frac{1400 \text{ CCS/LLF}}{350 \text{ MS/LLF}} = 4.0$$

Note: This calculation can be done on a total office basis. The working main station count must include trunks such as PBX "dial 9" trunks which have an appearance on an LLF.

5.30 The line assignment guide is then constructed for Procedure No. 1 as illustrated in Table A. A list generated in this fashion provides a ***desired order*** of assignments into load units. This is achieved in the computer program by:

(a) Selecting a load unit which needs the largest CCS addition for the next assignment

(b) Subtracting the average CCS/MS from the CCS correction of the unit just selected

(c) Going back to (a).

5.31 The network administrator must determine the number of lines required to satisfy the assignment demand. A guide is then requested and prepared to fulfill that demand. The spare line equipment selected is recorded in the appropriate columns of the guide as it is being entered on the assignment lists. "NA" is noted when spare equipment is not available. The remaining columns are provided for administrative purposes such as listing the class of service, noting the assignment list number, etc.

5.32 Knowledge of the disconnect activity within a traffic unit is as important as knowledge of inward movement. The disconnect activity may counteract the efforts to bring load units closer to the average or it may satisfy a need for spare line equipment. The guide may also be used to account for this disconnect activity impact on CCS. This involves keeping track of the number of disconnects within designated HGs and incorporating the information into the guide. For example:

(a) With the understanding that every disconnect negates an assignment, a flagging system may be devised to identify in the line records those HGs with a consistent low-usage trend. As disconnects occur within these HGs, they should be noted on the guide and entered on an assignment list, or

(b) Shortages of spare equipment (NAs) begin to appear when the traffic unit is working at a high-percentage fill. When an NA is noted on the guide, an indication should also be made in the line records in order to take advantage of the disconnect activity. The presence of an NA means that there is still a requirement for additional CCS.

5.33 The foregoing procedure specifies the order of assignment of lines by a network administrator. It is still the administrator's responsibility to determine both the class of service of available lines and how many lines should be given to the assignment office.

5.34 ***Alternative Procedure No. 2:*** In Procedure No. 1, each customer is assumed to generate approximately the same usage. This is not always the case. Traffic units that include several broad classes of service, or possess a few distinct classes may not find it effective to load by average office CCS. In this case, alternative Procedure No. 2 is developed to distinguish between lines with different load characteristics.

5.35 There are several ways to establish a CCS/MS by class of service. Two ways that are used in most instances today are:

- Subscriber line usage (SLU) studies
- Utilization of CCS/MS data of traffic units with similar characteristics.

5.36 First, establish a CCS per main station for each class of service. Select major classes within the loading division and place them in ranges, such as light (LCCS), medium (MCCS), and heavy (HCCS). Medium and heavy usage customers are assumed to have two and three times the LCCS, respectively.

5.37 The line assignment guide is constructed in a manner similar to the one for Procedure No. 1.

(a) Select a load unit which needs the largest CCS addition for the next assignment.

(b) Subtract LCCS from the CCS correction of the unit just selected.

(c) Going back to (a).

5.38 An example of an assignment list established according to Procedure No. 2 is shown in Table B. The guide is prepared according to the type of user being assigned. For example, if the network administrator assigns a light user in a load unit, an L is placed adjacent to the load unit's appearance on the list and the remaining columns filled in as described in 5.31. If a medium user is assigned, a line should be drawn through the assigned column adjacent to the ***first*** appearance of the load unit. An M and the appropriate information are placed adjacent to the ***second*** appearance of that load unit. A heavy user is designated by drawing a line through the first ***two*** appearances of the load unit and all required information is placed opposite the ***third*** appearance on the guide. The disconnect activity should be acknowledged as outlined in 5.32.

5.39 ***Manual Procedure:*** In manual data processing environments it is uneconomical to expend clerical time to achieve all four of the features mentioned in 5.16. The approach shown in the following paragraphs is recommended as a compromise for manual offices.

5.40 For clerical ease, the proposed plan uses weekly scores in a manner similar to present balancing procedures, rather than actual CCS values (as used in the mechanized plan). The plan weighs recent data more heavily than older data and attempts to correct horizontal group loads to average usage without overcorrecting.

5.41 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:

$$\text{CCS correction} = \frac{\text{QCL} \times \text{Average CCS} \times \text{F}}{3}$$

QCL = Quality control limit of the loading division

Avg. CCS = Average load unit load within the loading division during the week in which action will be taken.

$$\frac{\text{Average Load Unit Load}}{\text{Number of Study Hours}}$$

= (***Note:*** If this is not available, use the latest actual week's average load unit load.)

F = Factor derived from the scores and knowledge of study intervals

3 = Fixed factor.

5.42 Form E-6617 is used in the determination of CCS corrective values on a manual basis for each load unit. An example of the filled out form is shown in Fig. 9.

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

First Study

Step 1: Develop the corrective CCS values for each of the factor F possibilities shown below (negative scores produce CCS to be added and positive scores produce CCS to be subtracted). Place results at the top of the first section on Form E-6617.

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

SCORE	FACTOR (F)
±4	3.0
±2	1.0
±1	.5
0	0

Step 2: ***First study*** scores for each load unit are listed on the first section in the column labeled SC.

Step 3: Knowledge of each score will allow F factors to be 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.

Second Study

Step 5: Factor W is selected from the table below. This factor is a weighted estimate of past scores for each collection interval. It is placed on column W for each load unit in the second study.

FACTOR (W)

	FREQUENCY			
SCORE	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 four week intervals

Step 6: Add the W factors to each load unit score.

$$\text{W} + \text{SC} = \text{WSC}$$

Step 7: New F factors for this study and W factors for the next study are found in Fig. 10 for each WSC value, depending upon the collection interval being used.

Step 8: Only seven F factors are possible for the second and subsequent studies: 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 top of the appropriate column of Form E-6617.

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

Step 9: The appropriate corrective CCS values are then selected from this listing for the corresponding F factor for each load unit.

Subsequent Studies

Step 10 Scores for each load unit are listed in the column labeled SC.

Step 11: The scores listed in Step 10 are added to the W factors found in Step 7.

W + SC = WSC

Step 12: Same as Step 8.

Step 13: Same as Step 9.

5.44 Once corrective CCS values are established for each load unit during a study week, a line assignment guide can be constructed in one of the two alternative methods shown in the mechanized procedure. If they prove to be too difficult or time consuming to develop, a third alternative is proposed. This procedure is simply to establish a list similar to the one shown in 5.24. Extreme care must be taken, however, when it is utilized.

5.45 If a score is unavailable for a HG in a measurement period, it is suggested that the last weekly 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 week one and that the process be started anew.

5.46 ***Line Transfer Guide:*** Line transfer guides are constructed in a manner similar to the line assignment guides and are used primarily for decisions regarding line equipment transfer (LET) 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 an LCCS, depending upon the degree of detail required for administrative purposes (see Table C).

5.47 Proceeding in order of removal, the network administrator would enter an indication beside each load unit under the ***Selected*** column. For a No. 1 Crossbar office, this indication would be the column (COL), vertical file (VF) and class of service (CS). Disconnects would be accounted for before choosing lines to be transferred in order to avoid any overcorrection as discussed in 5.32.

6. LOAD BALANCE INDEX

6.01 The new load balance index (LBI) replaces the current LBI and overall balance index (OBI) with a single integrated index called the LBI. This new index applies to load units in all traffic unit types capable of terminating customer lines; eg, Step-by-Step, No. 1 Crossbar, No. 5 Crossbar, No. 1 ESS, and No. 2 ESS. Any traffic unit capable of supplying load unit usage data on at least a monthly basis will be indexed regardless of whether usage data processing and line assignments are performed manually or automatically.

6.02 Quality control limits for scoring take into account the traffic unit type, usage capacity, actual usage, and holding time. The new LBI is based on balance of a traffic unit with respect to average load, the percentage of capacity represented by actual usage and the presence of load unit loads in excess of preset thresholds above capacity.

6.03 The new LBI is designed to be a true performance index with an objective of 96 through 98 performance for all traffic units. The makeup of the new index will permit meaningful comparisons between all traffic units and groups of traffic units. The new LBI is intended to be treated as an official reported result and to be published in the AT&T performance results report. Customer service performance of a traffic unit will continue to be measured by the existing dial line index.

6.04 The new plan controls the usability of usage data for indexing purposes. The present plan allows for varying amounts of data to be used for indexing purposes and provides for factoring when the required studies are not available. In addition, indexes are carried over when no new studies are subsequently available. A study may consist of 5, 10, or 15 hours with a QCL adjustment based on the number of hours. The new plan indexes a traffic unit on the basis of a requirement for one usable ***10-hour study*** per month and is reported as ***not available*** for any month in which a valid study is not attained. The objective of this plan is to enforce uniformity of indexing by requiring comparable data from all traffic units.

6.05 The new plan continues to employ the ***score method*** to determine imbalances. As shown in Part 2, Principles of Load Balance, individual study score calculations are identical with the exception that new quality control limits, which are a function of load and holding time, are employed. However, there are significant differences in how the scores are combined into an index.

6.06 The ***present*** plan employs individual scores of ±1, ±2, and ±4 to realize a cumulative score (the algebraic sum of the individual scores on a horizontal group for the preceding five valid studies, if available; otherwise, standard factors are applied to lesser numbers of valid studies). The percentage of cumulative scores equal to or exceeding a value of ±9 is entered into a table to determine the present LBI. The OBI is then ascertained from a table by entering LBI and service (either IML or dial tone speed depending on office type). The new plan provides ***penalty points*** for all horizontal groups with scores of +4 only. Three penalty points apply for each +4 score in the current month's study, two penalty points apply for a +4 score in the preceding month, and one penalty point for each horizontal group scoring +4 in the previous preceding month. The cumulative penalty points for the current and two previous valid studies as a fraction of the total load units are entered along with the weighted percentage of engineered capacity into the new LBI table. If necessary, a negative correction is made to the LBI from the ***hot spot*** table based on the fraction of horizontal groups exceeding the present threshold above capacity. Thus the new plan is more responsive to imbalance when it occurs and is also more responsive when the imbalance is corrected.

6.07 Outstanding features of the new plan include the following:

(a) Improved QCL based on actual load and holding time.

(b) Elimination of nonadjacent busy hours for study use.

(c) Correction of +4 horizontal groups is the only means to improve index; overcorrection does not improve index.

(d) Equipment additions are indexed as a separate loading division for up to six months after addition completion.

(e) Elimination of index suspension because of line transfers.

(f) Equipment operating below 30 percent of engineered capacity is not indexed.

(g) Highlight of horizontal groups exceeding heavy load thresholds (hot spots).

7. ABBREVIATIONS AND ACRONYMS

ABBREVIATIONS	TITLE
ACCS	Average Hundred Call Second
AHT	Average Holding Time
AL	Actual Load
BH	Busy Hour
BIS	Business Information System
CBH	Class Busy Hour
CCS	Hundred Call Seconds
CCS/LLF	Hundred Call Seconds Per Line Link Frame
CCS/MS	Hundred Call Seconds Per Main Station
CN	Coin
COL	Column
COSMIC	Common System Main Interconnecting
CS	Class of Service
DFMP	Dial Facilities Management Practices
DGU	Detector Group Usage
DID	Direct In Dialing
DJPC	District Junctor Peg Count
DP	Dial Pulse
DTF	Dial Tone First
EADAS	Engineering Administration Data Acquisition System
EL	Engineering Load
HCCS	Heavy Hundred Call Second
HG	Horizontal Group

ILF	Incoming Link Frame
IML	Incoming Matching Loss
LBI	Load Balance Index
LBS	Load Balance System
LCCS	Light Hundred Call Second
LD	Loading Division
LE	Line Equipment
LET	Line Equipment Transfer
LJU	Line Junctor Usage
LIT	Line Insulation Test
LLF	Line Link Frame
LLHC	Line Link Horizontal Count
LLOC	Line Link Office Count
LLP	Line Link Pulsing
LU	Load Unit
MB	Message Business
MCCS	Medium Hundred Call Seconds
MDF	Main Distributing Frame
MIG	Modified Incoming Group
MR	Message Residence
MS	Main Station
NA	Not Available
OMG	Originating Marker Group
OTC	Operating Telephone Company
PACE	Program for Arrangement of Cables and Equipment
PBX	Private Branch Exchange
PSO	Percent Sample Originating
QCL	Quality Control Limits
SCPC	Sample Channel Peg Count
SBH	Session Busy Hour
SLU	Subscriber Line Usage
SU	Sample Usage
SXS	Step by Step
TCPC	Total Channel Peg Count
TD	Toll Denial
TMG	Terminating Marker Group
TPC	Terminating Peg Count
T/S	Total to Sample
TU	Traffic Unit
TUR	Traffic Usage Recorder
VF	Vertical File
WATS	Wide Area Telephone Service
WKGMS	Working Main Station
WT	Working Terminations
XB	Crossbar

(MARCH 1975)

LOAD BALANCE QUALITY CONTROL LIMITS
BASED ON 10 HOUR DATA

NO. 1 & 5 CROSSBAR

AVERAGE HOLDING TIME (SECS)	ACTUAL AVERAGE LOAD PERCENTAGE OF ENGINEERING LOAD																											
	30% TO 35%							36% TO 45%							46% TO 55%							56% TO 65%						
	LLF CCS CAPACITY							LLF CCS CAPACITY							LLF CCS CAPACITY							LLF CCS CAPACITY						
	1460 – 1660	1300 – 1459	1160 – 1299	1040 – 1159	940 – 1039	860 – 939	780 – 859	1460 – 1660	1300 – 1459	1160 – 1299	1040 – 1159	940 – 1039	860 – 939	780 – 859	1460 – 1660	1300 – 1459	1160 – 1299	1040 – 1159	940 – 1039	860 – 939	780 – 859	1460 – 1660	1300 – 1459	1160 – 1299	1040 – 1159	940 – 1039	860 – 939	780 – 859
0 – 70	32	34	36	38	40	42	44	28	29	31	33	35	36	38	25	26	28	29	31	33	34	23	24	25	27	28	30	31
71 – 90	37	39	41	44	46	48	51	32	34	36	38	40	42	44	28	30	32	34	36	38	39	26	28	29	31	33	34	36
91 – 110	41	44	46	49	51	54	57	36	38	40	42	45	47	49	32	34	36	38	40	42	44	29	31	33	35	37	38	40
111 – 130	45	48	51	53	56	59	62	39	41	44	46	49	51	54	35	37	39	42	44	46	48	32	34	36	38	40	42	44
131 – 150	48	51	55	58	61	64	67	42	45	47	50	53	55	58	38	40	42	45	47	50	52	34	37	39	41	43	45	47
151 – 170	52	55	58	62	65	68	71	45	48	51	53	56	59	62	40	43	45	48	51	53	55	37	39	41	44	46	48	51
171 – 190	55	58	62	65	69	72	76	48	51	54	57	60	63	66	43	45	48	51	54	56	59	39	41	44	46	49	51	54
191 – 210	58	62	65	69	73	76	80	50	53	57	60	63	66	69	45	48	51	54	56	59	62	41	44	46	49	52	54	57
211 – 230	61	65	68	72	76	80	84	53	56	59	63	66	69	73	47	50	53	56	59	62	65	43	46	49	51	54	57	59
231 – 250	63	67	71	75	80	83	87	55	58	62	65	69	72	76	49	52	55	59	62	65	68	45	48	51	54	56	59	62
251 – 270	66	70	74	79	83	87	91	57	61	64	68	72	75	79	51	54	58	61	64	67	71	47	50	53	56	59	62	65
271 – 290	68	73	77	81	86	90	94	59	63	67	71	75	78	82	53	57	60	63	67	70	73	49	52	55	58	61	64	67
291 – 310	71	75	80	84	89	93	98	61	65	69	73	77	81	85	55	59	62	66	69	72	76	50	53	57	60	63	66	69
311 – 330	73	78	82	87	92	96	*	63	67	71	76	80	84	88	57	60	64	68	71	75	78	52	55	58	62	65	68	72
331 – 350	75	80	85	90	95	99	*	65	70	74	78	82	86	90	59	62	66	70	74	77	81	54	57	60	64	67	70	74
351 – 370	78	82	87	92	97	*	*	67	72	76	80	85	89	93	60	64	68	72	76	79	83	55	59	62	66	69	73	76
371 – 390	80	85	90	95	*	*	*	69	74	78	82	87	91	95	62	66	70	74	78	82	85	57	60	64	67	71	75	78
391 – 410	82	87	92	97	*	*	*	71	75	80	85	89	93	98	64	68	72	76	80	84	88	58	62	65	69	73	76	80
411 – 430	84	89	94	*	*	*	*	73	77	82	87	91	96	*	65	69	73	78	82	86	90	59	63	67	71	75	78	82
431 – 450	86	91	97	*	*	*	*	74	79	84	89	93	98	*	67	71	75	79	84	88	92	61	65	69	73	76	80	84
451 – 470	88	93	99	*	*	*	*	76	81	86	91	96	*	*	68	72	77	81	86	90	94	62	66	70	74	78	82	86
471 – 490	90	95	*	*	*	*	*	78	83	88	93	98	*	*	70	74	78	83	87	92	96	64	68	72	76	80	84	88

* FOR QCL DATA IN THIS RANGE CONSULT WITH AT&T COMPANY STAFF

Fig. 1—Load Balance Quality Control Limits Based on 10-Hour Data (Sheet 1 of 2) (2.30, 2.35, 2.37, 3.55)

(MARCH 1975)

LOAD BALANCE QUALITY CONTROL LIMITS
BASED ON 10 HOUR DATA

NO. 1 & 5 CROSSBAR

AVERAGE HOLDING TIME (SECS)	ACTUAL AVERAGE LOAD PERCENTAGE OF ENGINEERING LOAD																											
	66% TO 75%							76% TO 85%							86% TO 95%							96% AND UP						
	LLF CCS CAPACITY							LLF CCS CAPACITY							LLF CCS CAPACITY							LLF CCS CAPACITY						
	1460 – 1660	1300 – 1459	1160 – 1299	1040 – 1159	940 – 1039	860 – 939	780 – 859	1460 – 1660	1300 – 1459	1160 – 1299	1040 – 1159	940 – 1039	860 – 939	780 – 859	1460 – 1660	1300 – 1459	1160 – 1299	1040 – 1159	940 – 1039	860 – 939	780 – 859	1460 – 1660	1300 – 1459	1160 – 1299	1040 – 1159	940 – 1039	860 – 939	780 – 859
0 – 70	21	22	24	25	26	28	29	20	21	22	23	25	26	27	18	20	21	22	23	24	25	18	19	20	21	22	23	24
71 – 90	24	26	27	29	30	32	33	23	24	25	27	28	30	31	21	23	24	25	27	28	29	20	21	23	24	25	27	28
91 – 110	27	29	30	32	34	35	37	25	27	28	30	32	33	35	24	25	27	28	30	31	33	23	24	25	27	28	30	31
111 – 130	29	31	33	35	37	39	41	28	29	31	33	35	36	38	26	28	29	31	33	34	36	25	26	28	29	31	33	34
131 – 150	32	34	36	38	40	42	44	30	32	34	36	37	39	41	28	30	32	33	35	37	39	27	28	30	32	33	35	37
151 – 170	34	36	38	41	43	45	47	32	34	36	38	40	42	44	30	32	34	36	38	40	41	29	30	32	34	36	38	39
171 – 190	36	38	41	43	45	48	50	34	36	38	40	42	44	47	32	34	36	38	40	42	44	30	32	34	36	38	40	42
191 – 210	38	40	43	45	48	50	52	36	38	40	42	45	47	49	34	36	38	40	42	44	46	32	34	36	38	40	42	44
211 – 230	40	42	45	48	50	53	55	37	40	42	44	47	49	52	35	37	40	42	44	46	49	33	36	38	40	42	44	46
231 – 250	42	44	47	50	52	55	57	39	41	44	46	49	51	54	37	39	41	44	46	48	51	35	37	39	42	44	46	48
251 – 270	43	46	49	52	54	57	60	41	43	46	48	51	53	56	38	41	43	46	48	50	53	36	39	41	43	46	48	50
271 – 290	45	48	51	54	57	59	62	42	45	47	50	53	55	58	40	42	45	47	50	52	55	38	40	42	45	47	50	52
291 – 310	47	50	52	55	58	61	64	44	46	49	52	55	57	60	41	44	46	49	52	54	57	39	41	44	46	49	51	54
311 – 330	48	51	54	57	60	63	66	45	48	51	54	57	59	62	42	45	48	51	53	56	59	40	43	45	48	51	53	56
331 – 350	50	53	56	59	62	65	68	46	49	52	55	58	61	64	44	47	49	52	55	58	60	42	44	47	49	52	55	57
351 – 370	51	54	57	61	64	67	70	48	51	54	57	60	63	66	45	48	51	54	57	59	62	43	45	48	51	54	56	59
371 – 390	52	56	59	62	66	69	72	49	52	55	58	62	65	68	46	49	52	55	58	61	64	44	47	49	52	55	58	61
391 – 410	54	57	61	64	68	71	74	50	54	57	60	63	66	69	47	50	53	57	60	63	65	45	48	51	54	57	59	62
411 – 430	55	59	62	66	69	73	76	52	55	58	61	65	68	71	49	52	55	58	61	64	67	46	49	52	55	58	61	64
431 – 450	56	60	64	67	71	74	78	53	56	59	63	66	70	73	50	53	56	59	62	66	69	47	50	53	56	59	62	65
451 – 470	58	61	65	69	72	76	80	54	57	61	64	68	71	74	51	54	57	61	64	67	70	48	51	54	58	61	64	67
471 – 490	59	63	66	70	74	78	81	55	59	62	66	69	73	76	52	55	59	62	65	68	72	49	52	56	59	62	65	68

Fig. 1—Load Balance Quality Control Limits Based on 10-Hour Data (Sheet 2 of 2) (2.30, 2.35, 2.37, 3.55)

INSTRUCTIONS FOR PREPARING FORM E-6618
MULTIPLE SIZE LLF CLASS-OF-SERVICE DISTRIBUTION

(1) Enter the name of the *building.*

(2) Enter the identification of the *traffic unit.*

(3) Enter the *loading division* designation, if applicable.

(4) Main Stations *(MS)* — Enter the projected number of main stations by broad class of service, business (B), residential (R) and coin (C). *Coin used for No. 5 Crossbar only.* Total the main stations for the loading division (LD).

(5) *CCS/MS* — Develop a CCS/MS for each broad category with subscriber line usage (SLU) studies, etc. Utilize the projected LD CCS/MS.

b = business CCS/MS, r = residential CCS/MS, c = coin CCS/MS

(6) *CCS* — Enter the product of lines 4 and 5 for each column B, R, C, and LD. The sum of B, R, and C must equal the CCS for LD. If not, the CCS/MS for each C of S must be reviewed. Approximations may be necessary.

(7) *Size* — Enter the size LLF for each grouping, eg, 290, 390, etc.

(8) *Number* — Enter the number of LLFs within each group L(1), L(2), and L(3) and total LD.

(9) *Terminations* — Product of lines 7 and 8 for each group. Sum groups for a total.

(10) % Fill — Total Office

$$\% \text{ Fill} = \frac{\text{Projected Main Stations}}{\text{Total Terminations (line 9)}} \times 100$$

— Small LLFs (column 1)
Assume a maximum percent fill. This value should be as high as possible and is a company option. Values between 95 and 97 percent are recommended.

— Larger LLFs (columns 2 and 3)
The actual percent fill for these groups will most likely be different than for small LLFs. However, for the purpose of a check to be made according to the instructions of 11 (d), use the same percentage as used for small LLFs.

(11) *WT/LLF* — Total Traffic Unit

$$\text{Average WT/LLF} = \frac{\text{LD Main Stations}}{\text{Total LLFs}}$$

— Each LLF size group (1, 2, and 3)

WT/LLF = Line 7 × Line 10

Fig. 2—Multiple Size LLF Class-of-Service Distribution Form E-6618 and Instructions for Preparation (Sheet 1 of 8) (3.36)

Notes: (a) If average WT/LLF is less than the WT/LLF for the smallest LLFs, all frames can be considered as being the same size. No further work is required on this form.

(b) If average WT/LLF is more than the smallest LLF WT/LLF (two size frames), further work will be required on this form.

(c) If average WT/LLF is more than the smallest LLF WT/LLF (three size frames), an attempt must be made to combine two of the three sizes for this procedure. Further work will be required on this form.

In general, the approach is to keep all LLFs loaded with approximately the same number and type of main stations. This may be accomplished, either by combining the small and medium frames, or combining the medium and large frames. When LLFs are combined into a group, extra terminations on the larger frames are assumed not to exist.

Small and Medium (designated *small* frames)

WT(1,2) = WT/LLF(1) × (L(1) + L(2))
WT(3) = Total MS − WT(1,2)

If WT(3) causes L(3) LLFs to be loaded to too high a level, try combining the medium and large frames.

Medium and Large (designated *large* frames)

WT(1) = WT/LLF(1) × L(1)
WT(2,3) = Total MS − WT(1)

(d) If average percent fill is greater than the assumed percent fill (line 10), each frame group may have to possess different characteristics in order to maintain the proper CCS/LLF.

(12) *CCS/LLF* — Planned CCS LD average not engineered CCS/LLF

$$\text{CCS/LLF} = \frac{\text{Line 6 (LD)}}{\text{Line 8 (Total)}}$$

(13) *Small LLF* — Working Main Stations/LLF

NO. 1 CROSSBAR

B(S) = Business main stations on small or combined small and medium LLFs.

$$\text{Approximate B(S)} = \frac{\text{CCS/LLF} - \text{r (WT/LLF)}}{(\text{b} - \text{r})}$$

Note: See instruction 11(c) for the proper WT/LLF to use for *small* LLFs in a three LLF size situation.

$$\text{Minimum Number Vertical Files} = \frac{\text{Approximate B(S)}}{10} \text{ (round up to the nearest integer)}$$

Note: Actual vertical files used are dependent upon the availability of the class of service identification by individual vertical file feature. (See 3.14 of this section.) If the feature is not available choose the next highest value VF(B) in the appropriate column below.

Fig. 2—Multiple Size LLF Class-of-Service Distribution Form E-6618 and Instructions for Preparation (Sheet 2 of 8) (3.36)

290	390	490	590	690
2	3	4	5	6
3	4	5	6	7
5	7	9	11	13
6	8	10	12	14
8	11	14	17	20
9	12	15	18	21
11	15	19	23	27
12	16	20	24	28
14	19	24	29	34
15	20	25	30	35
17	23	29	35	41
18	24	30	36	42
20	27	34	41	48
21	28	35	42	49
23	31	39	47	55
24	32	40	48	56
26	35	44	53	62
27	36	45	54	63
29	39	49	59	69

NO. 1 AND NO. 5 CROSSBAR

Actual B(S) = (line 10(1)) × VF(B) × 10
Actual R(S) = (WT/LLF) — actual B(S) — actual C(S)

(14) *Large LLF* — Working Main Stations/LLF

B(L) = Business working main stations on large or combined medium and large LLFs in a three LLF size situation.

$$B(L) = \frac{B - B(S) \times \text{Line } 8(1)}{\text{Line } 8(2) + \text{Line } 8(3)}$$

R(L) = Residential working main stations on large or combined medium and large LLFs in a three LLF size situation.

$$R(L) = \frac{R - R(S) \times \text{Line } 8(1)}{\text{Line } 8(2) + \text{Line } 8(3)}$$

Note: If small and medium LLFs are combined, use:

$$B(L) = \frac{B - (BS) \times \text{Line } 8(1) + \text{Line } 8(2)}{\text{Line } 8(3)}$$

$$R(L) = \frac{R - R(S) \times (\text{Line } 8(1) + \text{Line } 8(2))}{\text{Line } 8(3)}$$

(15) Vertical Files — Large LLFs

Fig. 2—Multiple Size LLF Class-of-Service Distribution Form E-6618 and Instructions for Preparation (Sheet 3 of 8) (3.36)

Note: This procedure is used only to apportion verticals across *large* LLFs. Actual main stations assigned should not exceed B(L) and R(L) and these stations should be spread evenly across all horizontal groups.

$$\text{Proportion Business} = P(B) = \frac{B(L)}{B(L) + R(L)}$$

$$\text{Proportion Residential} = P(R) = 1 - P(B)$$

$$VF(B) = \frac{\text{LLF Size}}{10} \times P(B)$$

Note: Round to the next higher integer. If the class of service identification by individual vertical file feature is not available, use the tables of line 13. When medium and large LLFs are combined, medium LLFs should be proportioned in the same manner.

(16) Actual *CCS/LLF*

	SMALL LLFs					LARGE LLFs			
	MS		CCS/MS		CCS	MS		CCS/MS	CCS
Business	B(S)	X	b	=	( )	B(L)	X	b	( )
Residential	R(S)	X	r	=	( )	R(L)	X	r	( )
Coin	C(S)	X	c	=	( )	C(L)	X	c	( )
Total	( )	X			( )	( )	X		( )

Note: CCS/LLF(s) should be approximately equal to CCS/LLF (L).

Fig. 2—Multiple Size LLF Class-of-Service Distribution Form E-6618 and Instructions for Preparation (Sheet 4 of 8) (3.36)

MULTIPLE LLF SIZE EXAMPLE

Basic Data:

— One originating marker group

— One terminating marker group — XX4 and XX5
— same rate treatment

— LLF configuration

	XX4			XX5			TOTAL		
Size	LLF	LE	WKGMS	LLF	LE	WKGMS	LLF	LE	WKGMS
390	24	9360	7025	13	5070	4361	37	14430	11386
290	—	—	—	13	3770	3332	13	3770	3332
Total	24	9360	7025	26	8840	7693	50	18200	14718

— Main stations (present and future — noncoin)

	XX4	XX5	TOTAL
Residence			
Message Residence (MR)	592	945	1537
Other	4134	4232	8366
Total	4726	5177	9903
Business			
Message Business (MB)	1540	2021	3561
PBX	582	355	937
Subtotal	2122	2376	4498
Total Denial (TD)	177	140	317
Total	2299	2516	4815
Grand total	7025	7693	14718

— Busy hours

— Capacities

Office limit — Originating markers @ 15250 MS.
Terminating markers or district junctors do not limit the terminating marker group (TMG).

— Load characteristics (present and future)

CCS/MS (office)
Present: 14357 MS WORKING

Fig. 2—Multiple Size LLF Class-of-Service Distribution Form E-6618 and Instructions for Preparation (Sheet 5 of 8) (3.36)

Average CCS/MS = 41535 ÷ 14357
= 2.89 say 290

Note: Load characteristics can meld because all frames serve the same rate structure.

Proposed: Average CCS/MS = 2.92
2.92 CCS/MS × 14718MS = 42977 CCS
42977 CCS ÷ 50LLF = 860 CCS/LLF

CCS/MS (Class of Service) Developed by SLU Studies

BUSY HOUR	RESIDENCE	BUSINESS	OFFICE
3:30 — 4:30	2.4	4.0	2.9

Check for reasonableness — 9903 (2.4) + 4815 (4.0) = 43027
14718 (2.92) = 42977
43027 ≈ 42977

Step 1:

Assume a maximum percent line fill per LLF (95 percent in this case) and check to see whether or not all line link frames can be considered as being the same size.

290 × 50 = 14500 Terminals
14500 × .95 = 13775 Main Stations
13775 is less than 14718, therefore, this approach cannot be used.

Step 2:

All noncoin 290 LLFs are then assumed to be working at 95 percent fill in order to allow as much load as possible to be placed on these frames. This will provide for a more equitable spread of high usage lines.

(a) Office Percent Fill = $\frac{14718 \text{ MS}}{18200 \text{ Terminals}}$

= 80.9%

(b) 290 × .95 = 276 MS/LLF
276 × 13 = 3588 MS
14718 — 3588 = 11130 MS

(c) 11130 MS ÷ 14430 Terminals (390 size LLFs) = 77.1%
390 × .77 = 301 MS/LLF

Fig. 2—Multiple Size LLF Class-of-Service Distribution Form E-6618 and Instructions for Preparation (Sheet 6 of 8) (3.36)

Step 3:

Determine the number of main stations, by class of service to be loaded on each 290 frame. Assume all frames carry approximately 860 CCS/LLF with business and residence CCS/MS remaining the same.

B = Number of business main stations
R = Number of residential main stations

$$B + R = 276$$
$$4.0\,B + 2.4R = 860$$

Solving these simultaneous equations:

B = 124 MS approximately
R = 152 MS approximately

Step 4:

Determine the number of business and residential verticals or main stations to be designated to each 290 LLF.

Business

124 Business ÷ .95 = 130.5 LE/LLF
Use *14 Verticals (see Note)

*If any vertical other than 0 is selected, 15 verticals must be designated as business.

Residential

29 — 14 = 15 Verticals

Note: Limitations within some No. 1 Crossbar LLFs preclude the possibility of utilizing individual verticals for classes of service. In all size frames the same vertical must be selected in each column, except for the first column in the frame, which has one vertical set aside for *no test.* The following show the only vertical combinations that can be selected:

290		390	
VERTICAL 0	ALL OTHERS	VERTICAL 0	ALL OTHERS
2	3	3	4
5	6	7	8
8	9	11	12
11	12	15	16
14	15	19	20
17	18	23	24
20	21	27	28
23	24	31	32
26	27	35	36
29	29	39	39

Therefore, 140 × .95 = 133 business MS/290 LLF
150 × .95 = 143 residential MS/290 LLF

Fig. 2—Multiple Size LLF Class-of-Service Distribution Form E-6618 and Instructions for Preparation (Sheet 7 of 8) (3.36)

Step 5:

Determine the number of lines to be assigned to 390 size frames and the percent fill.

Business

133 × 13 = 1729
4815 − 1729 = 3086
3086 ÷ 37 = 84 MS/LLF

Residential

143 × 13 = 1859
9903 − 1859 = 8044
8044 ÷ 37 = 217 MS/LLF

$$\text{Percent Fill} = \frac{84 + 217}{390} \times 100 = 77.0\%$$

Step 6:

Determine the number of business and residential verticals to be established in each 390 LLF.

3086 + 8044 = 11130

Business

$$\frac{3086}{11130} \times 100 = 28\%$$

390 × .28 = *11 verticals
*utilize vertical 0

Residential

390 × .72 = 28 verticals

Step 7:

Calculate the expected CCS/LLF and CCS/HG

290

133(4.0) + 143(2.4) = 875 CCS/LLF
875 CCS/LLF ÷ 10 HG = 87.5 CCS/HG

390

84 (4.0) + 217 (2.4) = 857 CCS/LLF
857 CCS/LLF ÷ 10 HG = 85.7 CCS/HG

NO. 1 & NO. 5 CROSSBAR
MULTIPLE SIZE LLF C OF S DISTRIBUTION

FORM E-6618 (MAY 1975)

1 BUILDING: A
2 TRAFFIC UNIT: XX4 − XX5
3 LOADING DIVISION:

		B	R	C	LD
4	MS	4815	9903	–	14718
5	CCS/MS	b= 4.00	r= 2.40	c= –	2.92
6	CCS	19200	23800	–	43000

		1	2	3	
7	SIZE	290	–	390	
8	NO.	L(1)= 13	L(2)= –	L(3)= 37	50
9	TERM.	3770	–	14430	18200
10	% FILL	95	–	95	80.9
11	WT/LLF	276	–	371	
12	CCS/LLF				860

13 SMALL LLF

APPROXIMATE B(S) = $\frac{(860)-[(2.40)(276)] + [(-)(- - -)]}{(4.00 - 2.40)} = 124$

APPROX. B(S) ÷ 10 = 12.4 | VF(B)= 14

ACTUAL B(S)= (.95)x(14)x10= 133 | ACT. R(S)= (276)−(133)−[–] = 143

14 LARGE LLF

$$B(L) = \frac{(4815)-(133)(13)}{(37)} = 84$$

$$R(L) = \frac{(9903)-(143)(13)}{(37)} = 217$$

15 VERTICAL FILES—LARGE LLF

$$P(B) = \frac{(84)}{(84) + (217)} = .28$$

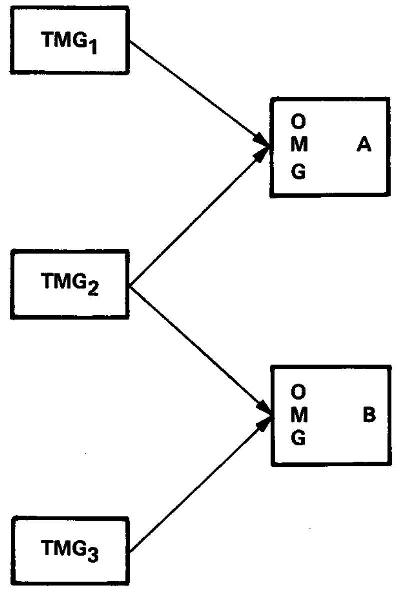
$$P(R) = 1 - (.28) = .72$$

$$VF(B) = \frac{(390)\ (.28)}{10} = 11$$

16 CCS/LLF

	SMALL LLF MS	x	CCS/MS	=	CCS	LARGE LLF MS	x	CCS/MS	=	CCS
BUSINESS –	133	x	4.0	=	532	84	x	4.0	=	336
RESIDENTIAL –	143	x	2.4	=	343	217	x	2.4	=	521
COIN –	–	x	–	=	–	–	x	–	=	–
TOTAL –	276				875	301				857

Fig. 2—Multiple Size LLF Class-of-Service Distribution Form E-6618 and Instructions for Preparation (Sheet 8 of 8) (3.36)



This schematic is simplified as this type of configuration could encompass more than three TMGs.

The calculations for percentage of capacity and AHT will require that the originating CCS (A + B) per proportioned to each TMG. This can be approximated by developing each TMGs ratio [percent sample originating (PSO)] of the total originating CCS ($OMG_A + OMG_B$).

$$PSO_{TMG_1} = \frac{(\text{LLF SU}_{TMG_1} - \text{ILF SU}_{TMG_1})}{(\text{LLF SU}_{TMG_1} - \text{ILF SU}_{TMG_1}) + (\text{LLF SU}_{TMG_2} - \text{ILF SU}_{TMG_2}) + (\text{LLF SU}_{TMG_3} - \text{ILF SU}_{TMG_3})}$$

Solve for $PSO_{TMG_2} + PSO_{TMG_3}$

Total usage is established for each TMG, in this manner:

$$\text{Total CCS}_{TMG_1} = \text{ILF SU} \times \text{T/S}_{TMG_1} + \text{DJU OMG A + B (PSO)}_{TMG_1}$$

The percentage of capacity is calculated for each TMG, as follows:

$$AL_{TMG_1} = \frac{\text{TOT CCS}_{TMG_1}}{\text{Number of HGs}_{TMG_1}}$$

$$\text{Percentage of capacity}_{TMG_1} = \frac{AL_{TMG_1}}{EL_{TMG_1}} \times 100$$

The AHTs for each TMG is computed in this manner:

$$AHT_{TMG_1} = \frac{\text{TOT CCS}_{TMG_1} \times 100}{TCPC_{TMG_1} + DJPC_{A+B}\ (PSO)_{TMG_1}}$$

Fig. 3—Nonstandard Traffic Unit Configuration (3.61)

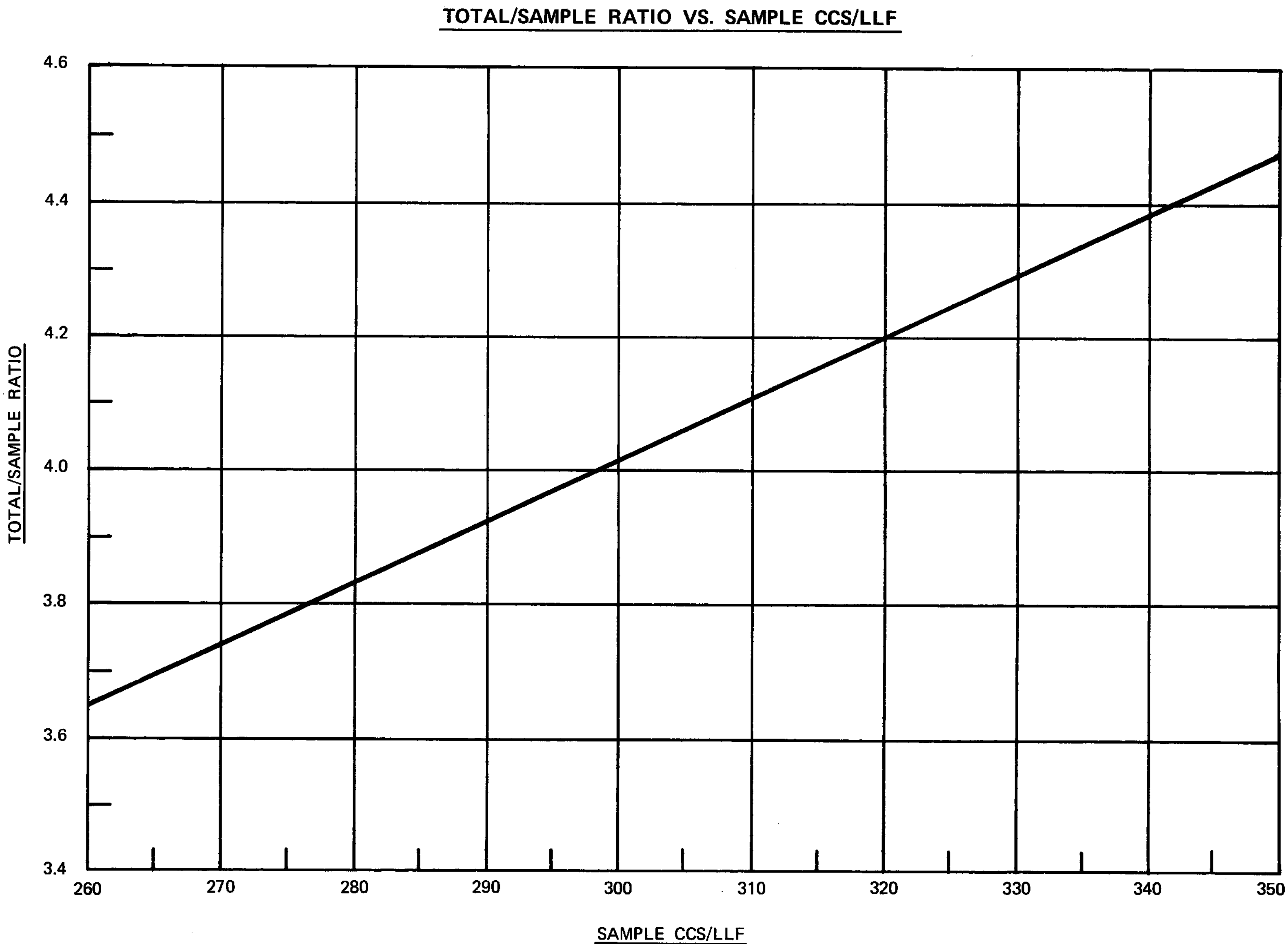


Fig. 4—Total-to-Sample (T/S) Ratio vs Sample CCS/LLF (3.64)

INSTRUCTIONS FOR PREPARING FORM E-6663

TRUNK LOAD UNIT SUMMARY

Building: Identify the building location.

Traffic Unit: Identify the traffic unit; eg, 241-CG0

LU Installed: Enter the number of trunk load units installed in the traffic unit.

LU CCS Capacity: Enter the engineered capacity in CCS for load unit in the traffic unit.

Study Date: Enter the beginning and ending date of each study; eg, 7-20 through 7-26-75.

LU Meas: Enter the number of trunk load units with valid data for the study.

Total CCS: Enter the total trunk usage read on the study. This should include usage only from trunk load units with valid data.

Avg. CCS: Divide the average CCS by the number of LUs measured. The result will be the average session load per load unit.

% of Capacity: Divide the average CCS by the number of study hours and by the LU CCS capacity. Then multiply by 100.

% IML: Enter the percentage of incoming matching loss for the study week.

Avg × *.85:* Multiply the average CCS by 85 percent.

Avg × *1.15:* Multiply the average CCS by 115 percent.

# of LU: Enter the number of trunk load units over 115 percent. This is obtained by adding up the number of "choice 4" units on the Trunk Load Unit Analysis form (E-6664).

% of LU: Divide the number of LUs (over 115 percent of average) by the LUs measured and multiply by 100.

TRUNK LOAD UNIT SUMMARY — Form E-6663 (7-75)

Building: Mesquite	Traffic Unit: DLLSTX MQ 279	Page of
LU Installed: 100	LU CCS Capacity: 250 (BH) 2500 (10 HR. SESSION)	

STUDY DATE	7/20-7/26/75					
LU MEAS	100					
TOTAL CCS	244900					
AVG CCS	2449					
% OF CAPACITY	98					
% IML	1.7					
AVG X .85	2094					
AVG X 1.15	2816					
LOADS OVER 115% OF AVERAGE						
# OF LU	18					
% OF LU	9					

STUDY DATE						
LU MEAS						
TOTAL CCS						
AVG CCS						
% OF CAPACITY						
% IML						
AVG X .85						
AVG X 1.15						
LOADS OVER 115% OF AVERAGE						
# OF LU						
% OF LU						

Fig. 5—Trunk Load Unit Summary Form E-6663 and Instructions for Preparation (3.113)

INSTRUCTIONS FOR PREPARING FORM E-6664

TRUNK LOAD UNIT ANALYSIS

Building: Identify the building location.

Traffic Unit: Identify the traffic unit; eg, 241-TMG0

Page of Number each page consecutively beginning with one and show total pages to list all trunk load units.

LU Installed: Enter the number of trunk load units installed in the traffic unit.

Study: Enter the study date using the beginning and ending date; eg, 7-20 through 7-26-75.

LU Ident.: Identify the trunk load unit abbreviation such as the incoming link frame (ILF) and switch (SW) in the two blank columns. List the LU identification numbers in sequential order.

CCS: Enter the study week's CCS value for the specified load unit.

Choice: Choices 1, 2, 3, 4 correspond to the orders of preference for assigning trunks.

Choice	Trunk Load Unit
1	Below 85 percent of average
2	Between 85 and 100 percent of average
3	Between 100 and 115 percent of average
4	Over 115 percent of average

% Cap: The percentage of capacity is only calculated for those trunk load units exceeding 100 percent of capacity. The LU CCS capacity on E-6663 multiplied by the number of study hours should be used when scanning the CCS column for LUs over capacity. The percentage of capacity for these LUs is calculated as follows:

1. $\frac{\text{CCS (LU)}}{\text{No. of Study Hrs.}} = \text{Average load for the LU}$

2. $\frac{\text{Average Load}}{\text{LU CCS Capacity}} \times 100 = \text{Percentage of capacity}$

TRUNK LOAD UNIT ANALYSIS FORM E-6664 (7-75)

Building: Mesquite | Traffic Unit: DLSTX MQ279 | Page of

LU Installed: 100

LU Ident.		STUDY: 7/20-7/26/75						STUDY:						REMARKS
		CCS	CHOICE				% CAP	CCS	CHOICE				% CAP	
ILF	SW		1	2	3	4			1	2	3	4		
00	00	2233		✓										
	01	2410		✓										
	02	1922	✓											
	03	2493			✓									
	04	3055				✓	122							
	05	2888				✓	116							
	06	2810			✓									
	07	1877	✓											
	09	2054	✓											
01	00	2934				✓	117							
	01	2917				✓	117							
	02	2726			✓									
	03	1996	✓											
	04	2375		✓										
	05	2111												

Fig. 6—Trunk Load Unit Analysis Form E-6664 and Instructions for Preparation (3.113)

INSTRUCTIONS FOR PREPARING FORM E-6615

SCORE CONTROL RECORD

Building — Enter the building identification.

Traffic Unit — Identify the traffic unit, eg, 241—MGO.

Loading Division — Identify the loading division.

LUs Installed — Enter quantity of load units installed in the loading division.

LU Eng. CCS — Enter the engineered capacity in CCS for a load unit in the loading division (All load units must be engineered or designed to operate at the same capacity.)

Study Date — Enter the beginning and ending date of each study, eg, 4—13 through 4—19—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.

% Eng. Cap. — Enter the percent the actual load is of the engineered capacity. The method for computing this percentage is outlined in 2.27 through 2.39 of this practice.

1) $\frac{\text{Total CCS}}{\text{LU s Meas.}}$ = Average weekly load

2) $\frac{\text{Average Weekly Load}}{\text{No. of Study Hours}}$ = Average load (AL)

3) $\frac{\text{Average Load}}{\text{LU Eng. CCS}} \times 100$ = Percentage of engineered capacity

Avg. H.T. — Enter the average holding time used on the study to select quality control limits. The method is outlined in 2.27 through 2.39.

% Column

+2 — The average CCS will be considered as 100 percent. Add the quality control limit figure (percent) found in the tables to 100 and enter here.

+1 — Add half the quality control limit figure to 100 and enter here.

0 — The average is considered as 100 percent.

−1 — Subtract half the quality control limit figure from 100 and enter here.

Fig. 7—Score Control Record Form E-6615 and Instructions for Preparation (Sheet 1 of 2) (5.02)

−2 — Subtract the quality control figure from 100 and enter here.

CCS Column

+2 — Multiply the figure in % column times the average CCS, divide by 100 and round all fractions to the nearest whole number and enter here, eg, 231.6 would be entered as 232, the upper limit for +2 scores.

+1 — Multiply the figure in % column times the average CCS, divide by 100 and 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 off to the nearest whole number and enter here.

−1 — Multiply the figure in % column times the average CCS, divide by 100 and round fractions a whole number and enter here, eg, 231.2 would be entered as 231.

−2 — Multiply the figure in % column times the average CCS, divide by 100 and round fractions to a whole number and enter here.

Note: Actual 10 hour sample usage readings may be substituted for CCS values, if preferred.

LOAD BALANCE SCORE CONTROL RECORD — Form E6615 (5-75)

Building: A | Traffic Unit: XX4 | Page ___ of ___

LOADING DIVISION ______ LU's INSTALLED 240 LU ENG. CCS 126

STUDY DATE							4/13- 4/19							
STUDY NO.	1		2		3		4		5		6		7	
TOTAL CCS							241000							
LU's MEAS.							240							
% ENG. CAP.							79.3							
AVG. H.T.							192							
	%	CCS	%	CCS	%	CCS	%	CCS	%	CCS	%	CCS	%	CCS
+2							140	1406						
+1							120	1205						
0	AVG.		AVG.		AVG.		AVG.	1004	AVG.		AVG.		AVG.	
−1							80	803						
−2							60	602						

LOADING DIVISION ______ LU's INSTALLED ______ LU ENG. CCS ______

STUDY DATE														
STUDY NO.	1		2		3		4		5		6		7	
TOTAL CCS														
LU's 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 ______ LU's INSTALLED ______ LU ENG. CCS ______

STUDY DATE														
STUDY NO.	1		2		3		4		5		6		7	
TOTAL CCS														
LU's 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. 7—Score Control Record Form E-6615 and Instructions for Preparation (Sheet 2 of 2) (5.02)

INSTRUCTIONS FOR PREPARING FORM E-6616

LOAD UNIT LINE LOAD BALANCE CHART

Building — Enter the building identification.

Loading Division — Identify the loading division.

Traffic Unit — Identify the traffic unit.

LU Installed — Enter quantity of load units installed in the loading division.

Page of — Number each page consecutively beginning with one 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 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.

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 total usage for the study period for each load unit (LG, HG, Conc or Conc Grp) on the study.

Note: Actual 10 hour sample usage readings may be substituted for CCS values if preferred. However, this will require the hot spot threshold value to be converted to reflect this approach. See DFMP, Division A, Section 5b.

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 DFMP, Division A, Section 5b, Load Balance Index Plan. The use of these spaces is optional.

- 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 entering the total penalty points for the report month. It is suggested 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 report month.

LOAD UNIT—LOAD BALANCE CHART Form E-6616 (5-75)

Building: A	Traffic Unit: XX4	Page of
Loading Division: —	LU Installed: 240	

~~LTN~~ ~~LLN~~ FR	~~LG~~ HG ~~Conc~~ ~~Conc Grp~~	STUDY DATE	2/9 - 2/15	3/2 - 3/8	3/9 - 3/15	4/13 - 4/19			
		STUDY NO.	1.	2.	3.	4.	5.	6.	7.
10	0	CCS	142	140	143	145			
		S P H	+4	+2	+4	+4			
	1	CCS	100	110	113	115			
		S P H	+1	+1	+1	+1			
	2	CCS	102	101	99	98			
		S P H	+1	+1	-1	-1			
	3	CCS	61	59	57	52			
		S P H	-2	-4	-4	-4			
	4	CCS	151	132	129	122			
		S P H	+4	+2	+2	+2			
	5	CCS	143	140	147	150			
		S P H	+4	+2	+4	+4			
	6	CCS	81	90	92	91			
		S P H	-1	-1	-1	-1			
	7	CCS	132	133	132	132			
		S P H	+2	+2	+2	+2			
	8	CCS	79	78	80	71			
		S P H	-2	-2	-1	-2			
	9	CCS	67	59	61	60			
		S P H	-2	-4	-2	-2			
		CCS							
		S P H							
		CCS							
		S P H							
		CCS							
		S P H							
		CCS							
		S P H							
		CCS							
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		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. 8—Load Unit—Load Balance Chart Form E-6616 and Instructions for Preparation (5.03)

FORM E-6617
(5-75)

CCS CORRECTION

Page of

BUILDING:							TRAFFIC UNIT:					LOAD UNITS:				
	F	STUDY 1 (5-4 to 5-9)					STUDY 2 (5-18 to 5-23)					STUDY 3 (6-1 to 6-6)				
		Q/3 X AVG. CCS X F					Q/3 X AVG. CCS X F					Q/3 X AVG. CCS X F				
	.5	.13 X 120 X .5 = 8					.12 X 130 X .5 = 8					.11 X 140 X .5 = 8				
	1.0	.13 X 120 X 1.0 = 16					.12 X 130 X 1.0 = 16					.11 X 140 X 1.0 = 15				
	2.0	.13 X 120 X 2.0 = 31					.12 X 130 X 2.0 = 31					.11 X 140 X 2.0 = 31				
	3.0	.13 X 120 X 3.0 = 47					.12 X 130 X 3.0 = 47					.11 X 140 X 3.0 = 46				
	4.0						.12 X 130 X 4.0 = 62					.11 X 140 X 4.0 = 62				
	5.0						.12 X 130 X 5.0 = 78					.11 X 140 X 5.0 = 77				
	6.0						.12 X 130 X 6.0 = 94					.11 X 140 X 6.0 = 92				
LOAD UNIT		W	SC	WSC	F	CCS CORR.	W	SC	WSC	F	CCS CORR.	W	SC	WSC	F	CCS CORR.
A			+4		3.0	-47	2.6	+4	6.6	6.0	-94	2.6	+4	6.6	6.0	-92
B			-2		1.0	+16	-1.3	-1	-2.3	1.0	+16	-0.9	0	-0.9	0	0
C			+1		0.5	-8	0.6	+2	2.6	1.0	-16	1.0	+2	3.0	1.0	-15
D			+2		1.0	-16	1.3	+1	2.3	1.0	-16	0.9	+1	1.9	0.5	-8
E			-4		3.0	+47	-2.6	-2	-4.6	2.0	+31	-1.8	-1	-2.8	1.0	+15
F			-1		0.5	+8	-0.6	-2	-2.6	1.0	+16	-1.0	-2	-3.0	1.0	+15
G			-2		1.0	+16	-1.3	-4	-5.3	3.0	+47	-2.1	-2	-4.1	2.0	+31
H			+1		0.5	-8	0.6	-1	-0.4	0	0	-0.2	+1	0.8	0	0

Fig. 9—CCS Correction Form E-6617 (5.42)

Page 1 of 2

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. 10—Factors (W) and (F) (Sheet 1 of 2) (5.43)

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. 10—Factors (W) and (F) (Sheet 2 of 2) (5.43)

TABLE A

LINE ASSIGNMENT GUIDE – PROCEDURE 1

CCS CAPACITY = 144
TYPE OF FRAME = 390
ESTIMATED CCS/MS = 4

DESIRED ORDER OF ASSIGNMENT	CCS TO ADD	LLF	HG	ASSIGNED COL	ASSIGNED VF	ASSIGNED CS	___	DISCONNECT COL	DISCONNECT VF	DISCONNECT CS	___
1	70	33	5	132	1						
2	66	33	5	134	2						
3	62	33	5	135	3						
4	60	26	9	104	1						
5	58	33	5	NA	NA						
6	56	26	9	104	2						
7	54	33	5	NA	NA						
8	54	13	1	52	1						
9	54	35	2	NA	NA						
10	53	6	1	27	1						
11	52	26	9	106	3						
12	50	33	5	NA	NA						
13	50	13	1	54	2						
14	50	35	2	NA	NA						
15	50	8	8	35	1						
16	49	6	1	24	2						
17	48	26	9	NA	NA						
18	46	33	5	NA	NA						
19	46	13	1	NA	NA						
20	46	35	2	NA	NA						

TABLE B

LINE ASSIGNMENT GUIDE – PROCEDURE 2

CCS CAPACITY = 144

TYPE OF FRAME = 390

LCCS = 3
MCCS = 6
HCCS = 9

DESIRED ORDER OF ASSIGNMENT	CCS TO ADD	LLF	HG	ASSIGNED COL	ASSIGNED VF	ASSIGNED CS		DISCONNECT COL	DISCONNECT VF	DISCONNECT CS	
1	70	33	5	L 133	1						
2	67	33	5								
3	64	33	5	M 134	2						
4	61	33	5								
5	60	26	9	L 103	1						
6	58	33	5								
7	57	26	9								
8	55	33	5	H 135	3						
9	54	26	9	M 104	2						
10	54	13	1	L 55	1						
11	54	35	2	NA	NA						
12	53	6	1	L 26	1						
13	52	33	5	NA	NA						
14	51	26	9								
15	51	13	1								
16	51	35	2	NA	NA						
17	50	6	1								
18	50	8	8	L 35	1						
19	49	33	5	NA	NA						
20	48	26	9	M 105	9						
21	48	13	1	M 55	2						

TABLE C

LINE TRANSFER GUIDE

CCS CAPACITY = 144
TYPE OF FRAME = 390
ESTIMATED CCS/MS = 4

DESIRED ORDER OF ASSIGNMENT	CCS TO REMOVE	LLF	HG	SELECTED COL	SELECTED VF	SELECTED CS	____	DISCONNECT COL	DISCONNECT VF	DISCONNECT CS	____
1	70	25	5	103	1						
2	66	25	5	100	2						
3	62	25	5	101	3						
4	60	16	9	64	1						
5	58	25	5	—	—			103	4		
6	56	16	9	64	2						
7	54	25	5	—	—			101	2		
8	54	23	1	92	1						
9	54	39	2	—	—			156	1		
10	53	8	1	33	1						
11	52	16	9	66	3						
12	50	25	5	—	—			103	3		
13	50	13	1	54	2						
14	50	39	2	—	—			158	3		
15	50	10	8	41	1						
16	49	8	1	34	2						
17	48	16	9	66	5						
18	46	25	5	102	9						
19	46	23	1	93	4						
20	46	39	2	156	7						

LOAD BALANCE SCORE CONTROL RECORD

Form E6615
(5-75)

Building:	Traffic Unit:	Page of

LOADING DIVISION ______ LU's INSTALLED ______ LU ENG. CCS ______

STUDY DATE														
STUDY NO.	1		2		3		4		5		6		7	
TOTAL CCS														
LU's 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 ______ LU's INSTALLED ______ LU ENG. CCS ______

STUDY DATE														
STUDY NO.	1		2		3		4		5		6		7	
TOTAL CCS														
LU's 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 ______ LU's INSTALLED ______ LU ENG. CCS ______

STUDY DATE														
STUDY NO.	1		2		3		4		5		6		7	
TOTAL CCS														
LU's 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														

Form E-6616 (5-75)

LOAD UNIT—LOAD BALANCE CHART

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							
		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							
		CCS							
		S P H							
		CCS							
		S P H							
		CCS							
		S P H							

S-Study Score

P-Penalty Points

H-Hot Spot Penalty Points

FORM E-6617
(5-75)

CCS CORRECTION

Page of

BUILDING:							TRAFFIC UNIT:					LOAD UNITS:				
	F	STUDY					STUDY					STUDY				
		Q/3 X AVG. CCS X F					Q/3 X AVG. CCS X F					Q/3 X AVG. CCS X F				
	.5															
	1.0															
	2.0															
	3.0															
	4.0															
	5.0															
	6.0															
LOAD UNIT		W	SC	WSC	F	CCS CORR.	W	SC	WSC	F	CCS CORR.	W	SC	WSC	F	CCS CORR.

FORM E-6618
(MAY 1975)

NO. 1 & NO. 5 CROSSBAR
MULTIPLE SIZE LLF C OF S DISTRIBUTION

1	BUILDING:						1	2	3	
2	TRAFFIC UNIT:					7	SIZE				
3	LOADING DIVISION:					8	NO.	L(1)=	L(2)=	L(3)=	
		B	R	C	LD	9	TERM.				
4	MS					10	% FILL				
5	CCS/MS	b=	r=	c=		11	WT/LLF				
6	CCS					12	CCS/LLF				

13 SMALL LLF

APPROXIMATE B(S) = $\dfrac{(\quad)-[(\quad)(\quad)]+[(\quad)(\quad-\quad)]}{(\quad-\quad)}$ =

APPROX. B(S) ÷ 10 =

VF(B)=

ACTUAL B(S)= (   )x(   )x10=

ACT. R(S)= (   )–(   )–[   ] =

14 LARGE LLF

B(L)= $\dfrac{(\quad)-(\quad)(\quad)}{(\quad)}$ =

R(L)= $\dfrac{(\quad)-(\quad)(\quad)}{(\quad)}$ =

15 VERTICAL FILES–LARGE LLF

P(B)= $\dfrac{(\quad)}{(\quad)+(\quad)}$ =

P(R)= 1 – (   ) =

VF(B)= $\dfrac{(\quad)(\quad)}{10}$ =

16 CCS/LLF

	SMALL LLF					LARGE LLF				
	MS	x	CCS/MS	=	CCS	MS	x	CCS/MS	=	CCS
BUSINESS –		x		=			x		=	
RESIDENTIAL –		x		=			x		=	
COIN –		x		=			x		=	
TOTAL –										

TRUNK LOAD UNIT SUMMARY

Form E-6663
(7-75)

Building:	Traffic Unit:	Page of
LU Installed:	LU CCS Capacity:	

STUDY DATE						
LU MEAS						
TOTAL CCS						
AVG CCS						
% OF CAPACITY						
% IML						
AVG X .85						
AVG X 1.15						
LOADS OVER 115% OF AVERAGE						
# OF LU						
% OF LU						

STUDY DATE						
LU MEAS						
TOTAL CCS						
AVG CCS						
% OF CAPACITY						
% IML						
AVG X .85						
AVG X 1.15						
LOADS OVER 115% OF AVERAGE						
# OF LU						
% OF LU						

TRUNK LOAD UNIT ANALYSIS

FORM E-6664
(7-75)

Building:	Traffic Unit:	Page of
LU Installed:		

LU Ident.		STUDY:						STUDY:						REMARKS
		CCS	CHOICE				% CAP	CCS	CHOICE				% CAP	
			1	2	3	4			1	2	3	4		