VERIFICATION
OF
CENTRAL OFFICES

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Issued by
GENERAL INSTALLATION ENGINEER

February, 1930

Reprinted April, 1930

33 (2)

PRINTED IN U. S. A.

PREFACE

This pamphlet is issued for the benefit of the Western Electric installer and is for the purpose of supplementing in a descriptive way the technical information on central office verification procedures and sampling inspection method of verification now given in the installing methods handbooks. The subject matter of this pamphlet is not intended to prescribe methods but rather to present the practical application of the technical information on verification in detail greater than is usually given in method handbooks.

The descriptive matter is presented so that a progressive reading may be obtained. Thus, a brief description of the broad principles of verification and sampling procedures is presented by reading only the portions of the text printed with double spacing. A fuller development of the theoretical principles of verification and sampling is presented by reading the double and single spaced subject matter. For those who will be required to closely supervise, or actually make verifications the text printed in smaller type than the general subject matter will be of particular interest as those portions deal with concrete examples of the application of verification processes.

A number of charts are appended to this pamphlet which present graphically the operations involved in a complete verification of a central office installation. Handbook references are shown opposite each verification operation.

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1. VERIFICATION OF CENTRAL OFFICES

The aim of our efforts in the installation of central offices is to produce a job of standard quality with the least cost and expenditure of time. A completed installation should be in accordance with engineering requirements and the standards for good workmanship.

Installation work performed in accordance with the respective installation information will normally result in a standard quality job as defined by the requirements of the "Tolerance for Defects" Specifications. The quality conditions of a completed job is determined by an inspection process termed verification which requires a systematic review of the units of work or equipment during process or at the completion of the operation. The job verification should generally be made as the installation proceeds. While the verification procedure is an inspection process it is also essentially an installation procedure as the inspection is not separate and distinct from the installation operations but is an essential detail of the methods. Examples are given throughout the text that follows illustrating how the verification methods may be applied during the progress of the work.

2. SAMPLING METHODS CONSIDERED FOR USE IN VERIFICATION PROCEDURES

The review of completed work may include the entire unit of work or equipment or it may be an observation made of a part of the total. Usually it is not necessary or desirable to look over the whole unit of equipment. The method of part observation is termed "sampling".

Whenever a partial observation is made an element of uncertainty is thereby introduced. This element of uncertainty is related entirely to the portion on which no observation is made. This uncertainty is of a three fold nature. The portion observed (sample) may indicate conditions which are identical with actual conditions, better than actual conditions or worse than actual conditions.

A knowledge of the quality condition of a central office installation should be attained with a reasonable degree of assurance. It is desirable that the degree of assurance be uniform under all circumstances and hence from an engineering point of view some limiting value for the assurance is necessary.

The operation of telephone equipment generally requires a high degree of assurance that the quality requirements are met and 90% is established as a minimum for this assurance. This means that in 9 out of every ten sampling trials, the portion selected for examination is representative of the whole lot. The sampling procedures prescribed in the engineering specifications are set up to meet this value of sampling assurance. In actual sampling operations the mathematical value of the assurance for quality conditions is generally greatly in excess of .9 and actually approaches .99 in most cases.

It is important that the exact sample sizes given in the handbook methods should always be observed in the verification of apparatus. If the sample size for a certain lot of relays is 180, exactly 180 relays should be checked. If more than 180 relays were checked then the chance of finding more defects than the AN value becomes greater. Should less than the 180 relays required be checked the sampling assurance of .9 previously mentioned would be reduced.

Having fixed the degree of assurance desired for a sampling verification of the completed work, it becomes a matter of considerable interest to determine what proportion of the whole equipment we need to examine. There must be some very definite proportion of the whole to observe which will fulfill the given limit of .9 assurance. Any amount over this definite part becomes an unnecessary expenditure of effort and correspondingly an observation made of less than the required definite part of the whole will increase the uncertainty. The study of these relations, namely the size of the total lot of parts, the tolerance for defects and the correct amount of the whole to be observed is mathematically treated under the Theory of Probability. The application in practice of specific rules for the selection of a sample is termed "Sampling".

3. APPLICATION OF SAMPLING IN CENTRAL OFFICE VERIFICATION PROCEDURES

The information on verification in the various installing handbooks is based on Specifications X-65561, X-65562 and X-65563. Handbook No. 35 describes the plan of these specifications. These specifications were developed in joint conference with the Laboratories engineers and the G.I.E.staff. They are modeled after and closely follow the preliminary information of the development studies of the G.I.E. staff.

3.1 <u>Grouping of Equipment:</u> The equipment of each office is treated as being sub-divided into groups of equipment. The groups of equipment are those that naturally suggest themselves to those familiar with the arrangement of a central office. For example in a manual office we think of the M.D.F., I.D.F., the subscriber's relay rack, trunk relay rack, the "A" Switchboard, etc. as distinct groups of equipment. Similarly in a panel office we have incoming selector frames, district selector frames, subscriber's sender frames, etc. as distinct groups of equipment, and in step-by-step offices the selector frames, connector frames, repeater frames, M.D.F. etc. are distinct groups of equipment. For sampling purposes the office is considered as being sub-divided into such basic groups of equipment and independent samples are selected from each of these basic equipment groups. These definite equipment groups are given in the verification section of the various handbooks.

With the basic equipment groups established the sub-division of these groups will naturally suggest itself. The "A" switchboard suggests a subdivision by sections, positions or panels; incoming selector group as subdivisions of frames; senders by units or frames; step-by-step selector switches by bays and shelves.

A central office installation has three types of requirements for which an inspection is made. They are:

(a) Apparatus adjustments

(b) Soldered Connections and Skinners

(c) Designations, Wiring, Framework Construction and Cabling.

The engineering requirements applying to the work under these broad classes of requirements are so unlike that of necessity there will be some variations specified for the sampling procedures under these classes. The differences in procedures are not great and in every instance care is taken that there will be no deviation from the basic concepts of theoretical sampling.

3.2 <u>Verifying Apparatus:</u> The apparatus mounted within each basic group of equipment is considered separately just as though each group was a separate central office. This treatment lends itself to detailing the verification processes and serves to localize the installation efforts in reconditioning apparatus when a sub-standard condition is indicated by a sampling inspection.

Each basic type of apparatus is sampled separately. In the case of relays each general type of relay is considered separately, that is, the flat type (A, E, F, H, R and T) relays are distinct from the B and G Types. For step-by-step offices each functional relay is considered separately for gauging, current flow, residual and stroke requirements and collectively for the other requirements.

3.3 <u>Verifying Soldering and Insulation:</u> Soldering is verified in a manner similar to that for apparatus adjustments. The verification of the completed soldering should include work done by the shop and work performed on the job. The equipment of the job is subdivided in the same basic equipment groups as for apparatus adjustments.

The sample size for soldering varies with the size of the basic equipment groups. The sample size is stated as 1/2, 1/3, 1/5, 1/10 etc. of the connections rather than a definite number of connections, in order to avoid counting the connections of the sample or of the basic equipment group. If the sample for inspection is 1/10 of the total connections, it is meant that 1/10 of the group of equipment should be examined using circuits, positions, multiple layers, mounting plates, terminal strips, etc. as the basis for estimating the proportional part of the basic group. The number of connections in the basic equipment group is determined by considering every frame in a panel office as equivalent to 16000 connections, a switchboard position (not including jacks or inaccessible wiring) as equivalent to 1600 connections, etc.

Soldering on certain equipment connected in the shop is practically inaccessible to the installer and it is not necessary to verify connections at such equipment unless testing results indicate an unsatisfactory condition of connecting. Equipment such as keys in keyshelves, 200 type selector banks, multiple banks of step-by-step switches, etc. are considered as having inaccessible connections.

For an example of the application of sampling to inspecting job soldering we will use the main distributing frame. Estimate the number of soldered connections on the M.D.F. before the soldering operation had actually commenced. This is done by multiplying the number of lines to be installed by two connections per line. The miscellaneous blocks on the M.D.F. should be multiplied by 60. The lot size is the sum of these two parts and the sample size stated as a fraction is determined from the table given in Handbook No. 9. Assume the fraction 1/5 as the sample size in this case. The number of blocks in the sample for inspection of soldering would be 1/5 of the total blocks on the M.D.F. By dividing the number of blocks in the sample by the days required to connect the M.D.F. the number of blocks to be inspected each day will be obtained. The sample should be made up of some blocks soldered by each workman in order to be assured that the work of each installer is satisfactory. Should an installer be untrained on this operation he should be closely checked until his work is satisfactory. The defects observed during the training period of an installer need not be charged against the sample provided the man's work is completely checked until he is thoroughly trained, likewise, the number of connections checked in such a case is not to be counted as part of the sample.

Having inspected the sample the number of connections inspected can be determined from the number of blocks checked and if the number of defects found is in excess of the allowable number of defects, i.e. 1 out of every 1000 connections inspected, the remaining blocks then should be completely checked for soldering.

When verifying shop soldering of subscriber's multiple the sample size of connections should be computed in terms of multiple layers and the first layers should be checked as they are being laid in the board until the sample size of multiple layers is obtained. If the AN for soldering is exceeded in the sample the remaining multiple should be completely checked as it is laid in the board. When a multiple tap is made the soldering of the tap should be checked as a separate lot from the regular shop soldered layers of multiple.

Soldering on certain other equipment where the equipment has an important part to play in the completion of subscribers calls should be completely checked. Equipment such as lamp panels on translator frames, fuse panels on panel selector frames, translator fuse panels, etc. fall in this category. Handbook No. 9 lists all the equipment that is to be completely checked for soldering.

3.4 Verifying Framework, Cabling, Designations and Power Operations

The verification of framework, cabling and designations consists of making an examination of a few completed units of work or equipment at scattered locations throughout the basic group of equipment. The sample size for this inspection is generally 25% of the operation but varies on certain equipment groups as shown on the table in Section No. 1.00 of Handbooks No. 9 or 30. Tolerances for defects are stated in a somewhat different manner than those used for apparatus adjustments or soldering. It is obviously impractical to enumerate every engineering requirement that applies to framework structures, cabling, etc. and specify a definite allowable number of defects for each. It is however, entirely practical to consider the observed deviation from a requirement of construction as of a major or minor magnitude. A deviation of major magnitude is one that may be considered as interfering with future growth, prevents efficient maintenance, gross misplacement of equipment, interferes with operation of circuits or seriously detracts from the appearance of the equipment. When the observed deviation from requirements does not do these things it is then a minor item. Major items (now class "A" items in handbooks) require correction whenever so determined. Minor items (now class "B" items) do not require correction except as noted in the sample unless there is an excessive number of repetitions of the same minor item.

To assist in checking the numerous requirements applying to erecting, cabling, etc. operations, at the end of each handbook method under "verification of work" a list of conditions is given that should exist in a correctly installed office. These verification items are to enable one to quickly observe that the work is correct in all particulars. This should be of value to supervisors as it will enable one to check quickly for all requirements without previously having to study in detail regarding just what is the actual statement of the requirement.

The tables in Figure 1 of Section 1.00 of Handbooks No. 9 and 30 give the average number of repetitions allowed for minor or class "B" items per unit inspected. This means that the number of positions, frames, bays, etc. checked in the sample should be multiplied by the average number of repetitions and the product is the allowable number for defects of any minor item found in the sample. As an example suppose a line-up of subscriber's switchboard has 28 positions. The sample size for this number of positions is 7 positions. The average number of repetitions allowed on a subscriber's switchboard is .8 defects per position. As the sample is 7 positions the number of defects allowed for that particular size sample is .8 x 7 = 5.6 defects. Stating defects in whole numbers, this is equivalent to 6 defects. It should be clearly understood that these 6 defects allowed refer to those of a similar character. For example terminal strips loosely mounted. If more than 6 terminal strips are noted as loosely mounted the remaining positions would be checked for loosely mounted terminal strips.

When verifying the work of frame erection, cabling, etc. check the work as it is being done in order to catch mistakes on the part of a workman before too large an area is involved. In further explanation of the application of the sample plan of verification to this class of installation work two examples will be given showing how equipment might be verified as the work is being performed. Consider the verification of alignment of frames, banks, drives, etc. The sample size is determined and the first frames, banks, etc. aligned should be checked while the gauges are still assembled. If the alignment of this equipment is satisfactory and the supervisor or delegated checker is sure the installer understands the operation these first frames, banks, etc. may be considered as applying to the sample and further checks will be made at intervals until the required sample number have been checked. However, should the first equipment aligned be incorrect and the installer is not entirely familiar with the gauges and methods then each unit of equipment worked on by the installer should be checked until the supervisor has confidence the installer will continue to perform the work correctly. When this point in the training period is reached the installers work can be considered as part of the sample for verifying the operation.

For another example of checking work as it is being performed take the case of placing cable brackets on the subscriber's relay rack. Assume that the sample is three bays which means that we should look at the mounting of cable brackets on three bays. The first bay on which the cable brackets have been mounted is checked and any defects noted should be referred to the installer so that the mistakes would not be repeated on other brackets. If errors were noted on the first bay the second bay should be checked, and so on. If the first bay was satisfactory the other two bays for the sample may then be selected at random locations.

4. SAMPLING PROCEDURES - APPARATUS ADJUSTMENTS

The number of relays of a general type, clutches or sequence switches in the sample varies according to the total number of a general type of relays, clutches or sequence switches in the basic equipment group. The greater the number of apparatus parts in the group the smaller the sample is in relation to the whole number. Actually more parts are selected for the sample in larger groups, but the percent selected will be less.

The X-specification tables in the various adjusting methods handbooks give the sample sizes, the "Tolerance Percents Defective" and the "Allowable Numbers for Defects". (For example, refer to table X-65561-08 of Handbook No. 6, Section No. 32). The "Tolerance Percent Defectives" are not to be used in sampling as they specify the amount of defects allowed in the whole equipment group rather than the sample. The "Allowable Defect Numbers" listed under each sample size are for use in sampling. These numbers for the sample are always less than the number of defects equivalent to the "Tolerance Percent Defective" in order to insure that the defects of the whole equipment group will be within the "Tolerance Percent Defective". The sample defect numbers more nearly equal the number of defects allowed by the "Tolerance Percent Defective" as the sample sizes increase.

4.1 Distribution of the Sample: Having determined from the table the number of apparatus units for the sample, it is important that the selection of these units be made from different locations of the basic equipment group. The parts of the sample should be representative of the conditions within the whole equipment group. The best possible way to obtain a good distribution would be to check each installers work in the proportion that each is to the whole. This can only be applied to apparatus adjustments or general installation operations performed on the job. The selection of a sample of work performed in the shop cannot be distributed on a workman basis as the installer has no knowledge of the individuals in the shop who worked on the equipment. The best that the installer can do would be to make a random selection of apparatus units within the equipment group. This may be done by selecting circuits, relay mounting plates, switchboard positions, etc. at widely distributed locations throughout the group of equipment involved. It is essential to select some of each code or type of apparatus making up the lot.

The number of defects observed within the sample for each X-specification or B.S.M.P. test requirement are tallied with the respective "allowable defect number" shown on the "Defect Tolerance and Sampling Requirement Tables" in the handbooks. If less than or equal to the allowable defect number (AN) no further action is required. If the number of defects is in excess of the allowable defect number (AN) it is concluded that the number of defects in the portion not observed is in excess of the engineering "Tolerance for Defects". In this case the remainder of the basic equipment group should be checked for the adjustment exceeding the allowable defect number.

The apparatus parts included within each basic group of equipment is separately sampled. When sampling, each fundamental type of apparatus should be sampled as separate lots. Having determined the various lots of apparatus in the group, refer to the "Defect Tolerance and Sampling Requirements" tables given in the apparatus handbooks in order to determine the particular sample size to use for the lot of apparatus in question.

The foregoing can be determined at any time in advance of the verification, either by the Foreman, sub foreman or the installer assigned to the work.

When the apparatus is ready for inspection the installer who is to perform the verification should be familiar with the information given in the Verification Section in the particular apparatus handbook. This section gives the information for the selection of the sample. The apparatus of the sample should be checked for all test requirements listed on the I. and M. or R.A.P. X-Specifications or the Bell System Maintenance Practices. The check of apparatus should include items of workmanship and special test notes listed on the circuit requirement tables. When a failure to meet a test requirement is observed the same should be tallied as a defect. All defects observed should be corrected. It is immaterial from a sampling standpoint whether defects are corrected when observed or corrected after the sample is inspected. There are merits to both plans and the choice is rather a matter of supervision and administration.

5. SPECIAL FEATURES IN SAMPLING PROCEDURES

There are certain features introduced in the plan for apparatus checking which are intended to increase the assurance that substandard conditions affecting but very limited portions of the equipment group will be detected, or which will reduce the verification effort where partial sampling results indicate conditions appreciably better than the respective tolerance for defects. We thus introduce "spottiness numbers", the "combining of basic equipment groups" to reduce the sample size, and how to determine when to discontinue inspection should no defects be observed.

5.1 Spottiness Numbers: Occasionally a small portion of the equipment may show an unusual number of defects and when such a condition exists it is termed a spotty condition. A spotty condition is determined in sampling procedures by comparing the number of defects observed in a definite portion of the sample with numbers termed spottiness numbers SN.

In further discussion of spotty conditions and spottiness numbers we will consider the case of verifying elevator apparatus in panel offices. The spotty condition on this equipment apply only to a frame. The "Defect Tolerance and Sampling Requirements" tables covering elevator apparatus have a column under each sample size headed "SN" Spottiness Number. When the number of defects found for any one inspection item exceeds the "SN" for that item on a frame then that frame is to be completely inspected for that item. When a frame has been completely checked for some item due to the frame sub-sample exceeding the corresponding SN the defects originally found for the item on that frame will not be counted in the total defects for the item in the sample. A limit has been specified as to the number of frames where the defects can be discounted from the total. This limit is 1/3 of the frames in the equipment group. When more than 1/3 of the frames have been completely checked for spotty conditions the remaining frames should be checked for that item.

Check the circuits in the sub-sample for elevator apparatus adjustments on the first frame or half frame adjusted by each installer. This will pick up the weak spots of the adjuster and enable the supervisor to direct his training on these adjustments before going to the next frame. By following this procedure the sample should indicate a satisfactory condition. The first frame adjusted probably would indicate spotty conditions as described in the following paragraphs but these frames could be completely checked and training should eliminate the spotty condition after one or two frames.

Spotty conditions of adjustments of Western Electric Co. type relays may exist in any one of three ways. Defects may be general on a frame or relay unit and would be thus considered as a spotty frame or relay unit. Defects may affect a particular code of relay in which case the relays of the affected code in the equipment group would be considered as a spotty group of relays. Defects may also be confined to the relays of a particular circuit; in this case the relays of that circuit are considered spotty and should be completely checked. Handbook No. 6 specifies the equipment groups that should be checked for spotty conditions on one of the three ways covered above.

As an example of a spotty defective condition on a particular code of relay consider the final frames on a panel job as the equipment group. Assume a lot of 1500 flat type relays consisting of 4 codes namely E-547, E-1383, E-548 and E-944. The sample to be inspected from a lot of 1500 E type relays would be 600. The 600 relays should be equally distributed among the frames on a circuit basis obtaining 150 of each code of relay. Assume that on the item of "Stud Gap" 9 defects were found in the sample. This number of defects is in excess of the "AN" of 3 given on X-65561-08 for this sample of E type relays. Ordinarily this defective condition would necessitate a 100% inspection of all the E type relays for this item. Before checking all four relay codes 100% observe whether the defects appear to be confined to one code of relays. Assume that upon investigation we find that 7 of the defects appeared on the E-944 relay. Locate the "SN" (spotty number) for this case by using table X-65561-08 part A. Under sizes of sub-sample we find the sub-sample size of 150 (126-175) and opposite this sub-sample size under the SN column is the number 6 which means that if more than 6 of the same defects were found on any one sub-sample the sub-lot (a frame, code of relay, circuit) can be considered spotty for that defect and should be completely inspected. As we found 7 stud gap defects on E-944, which is in excess of 6, all of the E-944 relays on the final frames should be checked for the stud gap requirements. This being the case only 2 defects (9 in sample minus 7 on E-944) would be chargeable against the sample which is under the AN of 3 and no further action would be necessary.

As an example of a spotty condition on a circuit basis consider the line relay frames in a panel office. On the line relay frames are located three different kinds of circuits namely line circuit, trip circuit and start circuit. Assume we have a "lot" of 2600 flat type relays on these frames. The sample for inspection is then 950 relays. The sample should be selected from among the various frames making sure to obtain relays from the three circuits named above as well as some of all codes. On the inspection of the sample of 950 relays 10 "contact follow" defects were found. This is in excess of 6 the AN (see table X-65561-08) and would necessitate a 100% inspection for contact follow adjustment. Upon an analysis of the inspection data it is found that 8 of the defects were found on the trip circuits. In the sample 48 relays were checked from the trip circuits, 52 from the start circuits and 850 from the line circuits. Using Table

X-65561-08 Part A in order to obtain the SN's for the above sub-samples we find that the SN for the trip circuit sub-sample of 48 relays is 3 therefore the SN was exceeded as 8 defects were found on contact follow in the trip circuits. The relays in the remaining trip circuits should be completely checked for the contact follow requirement. After discounting the 8 defects in the trip circuits only 2 more contact follow defects are left which is considerably within the AN of 6, therefore no further action would be necessary.

The application of spottiness numbers in the analysis of step-by-step equipment is in general similar to the procedures followed on manual and panel exchanges, differing only in minor applications. Where equipment common to all systems, such as W.E. Co. type relays appear on step-by-step offices they are sampled by the same procedures as followed for panel and manual exchange systems. On step-by-step equipment such as 197 type switches and horizontal type relays the sample for inspection is selected in sub-sample units of 5 switches from enough shelves to meet the sample size. This method does not require switches to be selected from all shelves and for that reason if a shelf sub-sample of switches or relays are found to have a spotty condition for any item all the switches or relays of that shelf should be completely checked for the item showing a spotty condition. When a shelf having the spotty condition for any item is completely checked the defects found are not counted in the total number of defects for the sample, but 5 switches from another shelf should be inspected in the place of the spotty shelf.

The number of defects allowed for a shelf or unit before they will be considered spotty are given, under the SN column on the Specification X-65562-09 requirement table.

Since switches are selected for inspection from only a portion of the shelves a limit has been placed on the number of shelves that may be discounted or replaced due to spottiness. If the number of shelves discounted or replaced, due to a spotty condition on the same item, exceed 1/7 of the original number of shelves in the sample then all the remaining equipment in the group shall be completely checked for that item.

Another spottiness requirement has been placed on step-by-step equipment which is similar to the code spottiness condition specified for W. E. Co. relays Step-by-Step relays are sampled for spring gauging (and other requirements) on a lot size basis of relays having the same functional designation. That is all "A" relays on the connector group would constitute one lot, "B" relays another lot, etc. Due to relays with the same functional designation on the connector group being of different codes and consequently having different requirements, one code of relay on the sampling check may show an excessive amount of defects while the other codes would be satisfactory in respect to number of defects. By checking these relays for code spottiness the effort in bringing these relays back to a satisfactory condition can be localized to the code or codes causing the unsatisfactory condition. To distinguish the code spottiness number from the shelf spottiness number (SN) the symbol CSN (code spottiness number) has been adopted.

As a further explanation of this feature an example is given. Assume a connector group consisting of 2180 switches with 2180,"B" functional designated relays consisting of 160 relays of the 222-AJ Code, 320 of the 222-A Code, 1365 of the 222-AT Code, 144 of the 222-E Code, 105 of the 222-OR Code and 86 of the 222-AR Code.

The sample size of 2180 "B" functional designated relays is given on requirement table X-65562-9 is 225 relays. This sample size should be distributed among the various codes in the approximate ratio that the number of each code of relay is to the total of "B" functional designated relays. It should be borne in mind however, that it is not advisable to have a sub-sample size of less than 5 relays of one code and also in meeting the sub-sample size of 5 or more care should be taken not to exceed the sample size which in the above example is 225 relays. The relays added to the sub-sample on the smaller number of coded relays can be subtracted from the larger.

The sub-sample sizes for the above codes should approximately be as follows: 20 of the 222-AJ code, 40 of the 222-A code, 130 of the 222-AT code, 15 of the 222-E code, 10 of the 222-OR code and 10 of the 222-AR code making a total of 225 "B" functional designated relays. The "CSN" for the sub-sample sizes given in the example above would be 2 for the 222-AJ code, 4 for the 222-A code, 11 for the 222-AT code, 1 for the 222-E code, 1 for the 222-OR code and 1 for the 222-AR code. The above method may also be applied on the Toll Selectors where the codes vary or some switches have more relays than others. The "AN" for defects to be used for the sample is determined by the number of associated pairs of contact springs for the relay code having the largest number of relays which in the above case would be the 222-AT code. The 222-AT relay has 4 to 5 associated pairs of contact springs and the AN for the above sample would be 9 for the gauging requirement. If more than 9 defects were found on the 225 relays checked in the sample after all spotty shelves have been replaced the entire lot of 2180 relays would have to be checked for the gauging requirement unless some particular code or codes of relay exceeded the "CSN" given on table X-65562-09 under code spottiness numbers. Should this be the case then those codes on which the "CSN" was exceeded are to be checked completely and the defects found in the sample on those codes need not be charged against the sample.

5.2 Combining Basic Equipment Groups: In certain cases it is permissible to combine similar basic equipment groups into one group in order to take advantage of the smaller sample size for the combined groups. In some panel offices the district, office, incoming and final selector frames each separately constitutes a group of a few frames. The sample for each separate group will be a large proportion of the whole group. When the district, office, incoming and final frames are considered as one basic group the group of frames will be larger and the sample size will be considerably smaller than if each group was considered separately. We cannot indiscriminately combine groups of equipment when the apparatus is quite different. This combining privilege is limited to elevator apparatus, sequence switches and relays on selector frames in panel offices.

Any one group of selector frames may be combined with another group if the groups to be combined have less than 850 selector circuits each or the resultant group has less than 1250 circuits. The sample size obtained from combining two equipment groups should be divided between the two groups in the approximate ratio that each is to the whole (combined lot). If an AN has been exceeded on a combined group it is satisfactory to make an analysis to see if the majority of the defects lie in one of the combined groups. Handbook No. 4 Section 15 gives a formula for obtaining a sub-AN (Proportional Defect Number P.D.N.) for each of the combined groups. When an AN has been exceeded in the combined group then the sub-AN (P.D.N.) for each of the combined groups should be obtained and if one of the sub-AN's (P.D.N.) is exceeded and not the other then it will only be necessary to completely check that group in which the sub-AN (P.D.N.) was exceeded.

As an example of the above, let us take two groups of equipment and combine them and work out the conditions as stated above. A group of office frames has 280 selector circuits and a group of final frames has 800 circuits, in combining the two we would have a lot of 1080 selector circuits. (If this sum had exceeded 1250 selector circuits these two groups could not have been combined). This combined group of 1080 selector circuits would call for a sample size for elevator apparatus of 230 selector circuits and dividing this sample size in an approximate ratio between the two combined groups we would have a sub-sample size of 60 selector circuits in the office group and a sub-sample size of 170 selector circuits in the final groups. These sub-samples of 60 and 170 should be equally distributed among the frames in the respective groups, selecting apparatus for inspection from each side of the frames.

Suppose that on the check of the sample of 230 selector circuits 24 "horizontal centering" items were found on multiple brushes and 20 of these items were on the final frames while 4 were on the office frames. Since 24 defects on this item exceeds the AN of 17 a sub-AN (P.D.N.) should be found for the office and final group separately. Using the formula given in Handbook No. 4, Section 15, we have AN (17) x lot size of office group (280) ÷ lot size of combined group (1080) = 4.4 or 4. This is the sub-AN for the office group. The sub-AN for the final group would be 17 x 800 ÷ 1080 or 12. Upon an analysis of the above it is found that the final frames exceeded 12 defects therefore all the final frames will have to be completely checked for horizontal centering of multiple brushes while the office frames had 4 defects which equalled the 4 allowed and for that reason no further action is necessary.

In the case of combining these groups for the sampling of relays the sample size will have to be determined by the relay lot. The office group with 280 selector circuits will also have 280 flat type relays while the final group with 800 selector circuits will have 3200 flat type relays making a combined lot of 3480 which will require a sample size of 950 relays. Breaking this sample up between the two groups in the proportion that each is to the whole we would have a sub-sample of 76 relays on the office frames and 874 in the final group. We do not use a sub-AN (P.D.N.) when combining groups for the inspection of relays as the application of the frame or code spottiness numbers should eliminate any case where an AN was exceeded and the majority of defects were found in the relays of one group of frames of the combined group.

5.3 Discontinuing Inspection on Partial Sampling: In some cases the manufacturing control of a process is so good that no appreciable number of defects exist or the margins for adjustments are generous and hence few defects arise in the manufacturing process.

In these cases the methods state inspection may be discontinued after 1/4 of the sample has been checked. Providing no defects were found. The adjustment requirements on which this may be done are designated by a star in the specification tables showing the allowable defect numbers. The items not starred require that the full sample be examined regardless of the fact that no defects are observed on the 1/4 part of the sample.

6. HOW SAMPLING MAY AID JOB ADMINISTRATION

In addition to the quality determination aspect of sampling it has possibilities for being a distinct aid to job supervision. To realize the benefit from the possibilities of sampling, the foreman, sub-foreman and other supervisors should be familiar with the plan for verification of installations as presented in the handbooks. It hardly seems sufficient to simply assign an installer to the duty of checking the adjustment of the relays or soldering without further following up his progress. He may not completely understand how to distribute his sample, or he may use the incorrect sample size, or his record of the check may be incomplete. When the sub-foreman, or foreman from time to time reviews briefly with the installer the results of his check and questions him as to how he is making his selections and knows whether he understands the adjustment, the installer will feel that his supervisors have an intelligent interest in his problem.

The analysis of the results of sampling inspection of adjusted apparatus by the supervisor is particularly important. We should have strong faith in the integrity and ability of the shop departments to do their work correctly, hence we can confidently take the stand that the apparatus adjustments, wiring, etc. are correct in all particulars. If when checking it develops that the installer making the check finds some adjustment of some apparatus part is greatly in excess of the allowable number of defects a question may be immediately raised by the supervisor as to whether the defective condition is a fact. A little investigation may show in such a case that the requirement was incorrectly interpreted. Two minds are more likely to discover a fault in application than one and in the event that an error in the check is discovered it may mean a saving of considerable readjustment. The finding of an excessive number of defects on the job check of apparatus may arise through applying the wrong requirement, incorrectly interpreting a requirement using a faulty gauge or instrument or from readjusting when an adjustment is close to or actually at the engineering limit.

The sampling plan of verification should help the supervisor in many ways. It should help him direct his training efforts where needed, show him the progress of his workmen, help him turn out a quality product, help him meet costs, give a systematic plan of verification and assist in preplanning his work.

7. RECORDS

Installations over a prescribed size (as shown in the apparatus handbooks) are required to prepare a summary report showing the results of the check of apparatus adjustments. Items on soldering, cabling, framework, designations, etc. however, do not require enumeration in a formal summary. From an administration viewpoint however, it seems advisable that some log should be kept of the checks which were made on these operations and the action taken when substandard conditions were observed. It is intended that the records of the job's verification be available for inspection by the

Telephone Company, if they so desire. After the completion of the job copies of the summary reports on apparatus adjustment (when job is of sufficient size) should be sent to the Division Office for distribution to the General Installation Engineer and Bell Telephone Laboratories.

These reports are used by the Bell Laboratories in studies as to the effectiveness and serviceability of apparatus designs, in studies to establish standards of quality and studies showing the general trends of quality of the equipment as delivered to the Telephone Companies. It is important therefore that the reports receive careful attention to insure that the information is complete in every detail and accurately tabulated. It should be appreciated that omission of data and inaccuracies in tabulation tends to discredit the entire report and may even cast reflection on installation work otherwise faithfully performed. Report forms have been provided in order that the tabulation of the verification data may be uniform from all installations.

Forms I.D. 1132 to 1139 inclusive have been developed for the purpose of recording and summarizing results of the sample check of apparatus adjustments. These forms were developed with the idea that defects would be corrected as found, and it would only be necessary to tally the number of defects found. In training programs it may be desirable that the defects should not be corrected as found and in those cases the form can be used for recording the location of the defects. The summary reports should show the lot size, sample size, (when two groups are combined the lot size of each should be given as well as the part of the sample selected from each of the two groups), action taken on items exceeding the AN and the number of places where a spotty condition was observed and corrected.

Before sending in the records they should be reviewed by the supervisors to see that the information is complete and that inspections were extended when sub-standard conditions were disclosed by the sample inspection.

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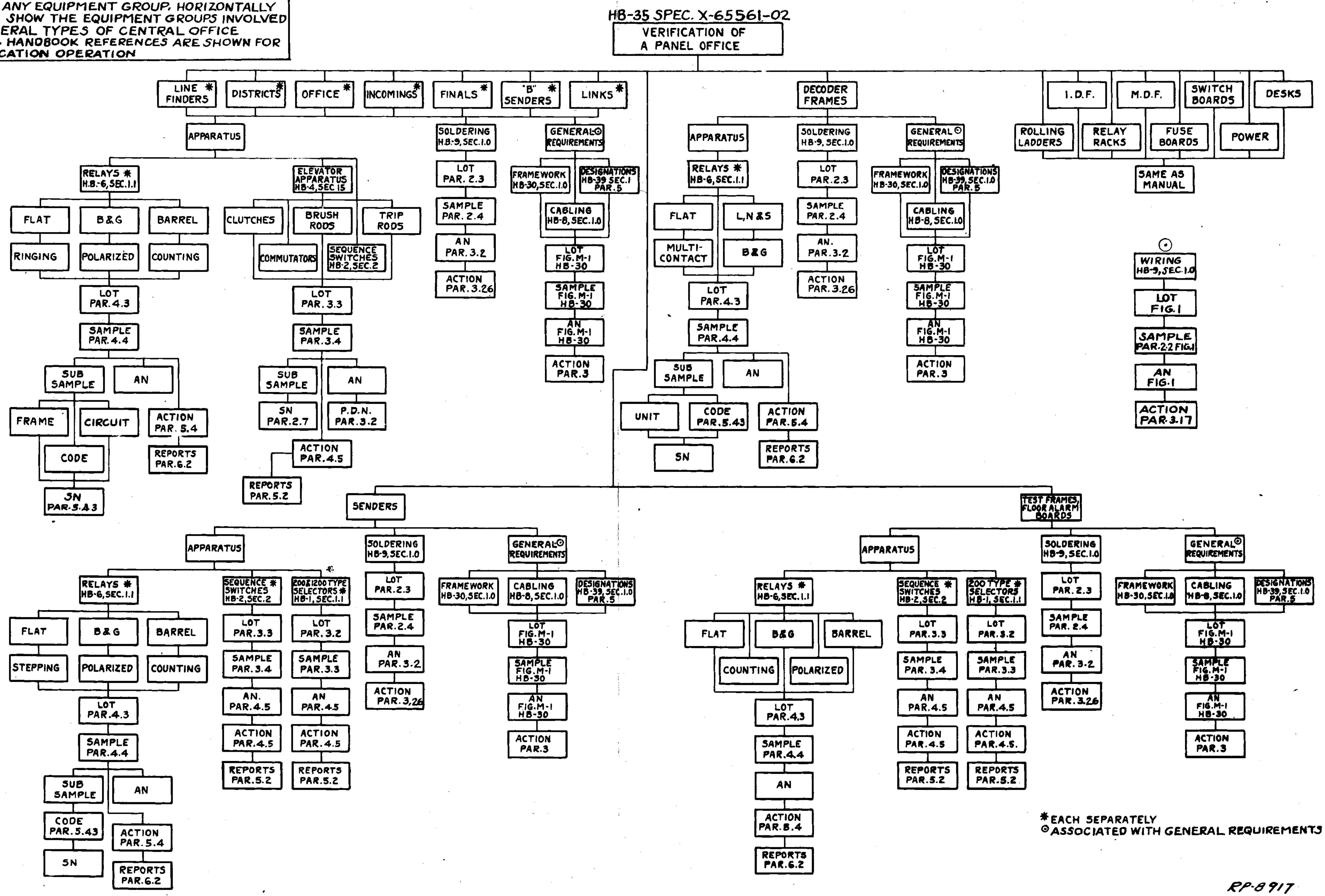
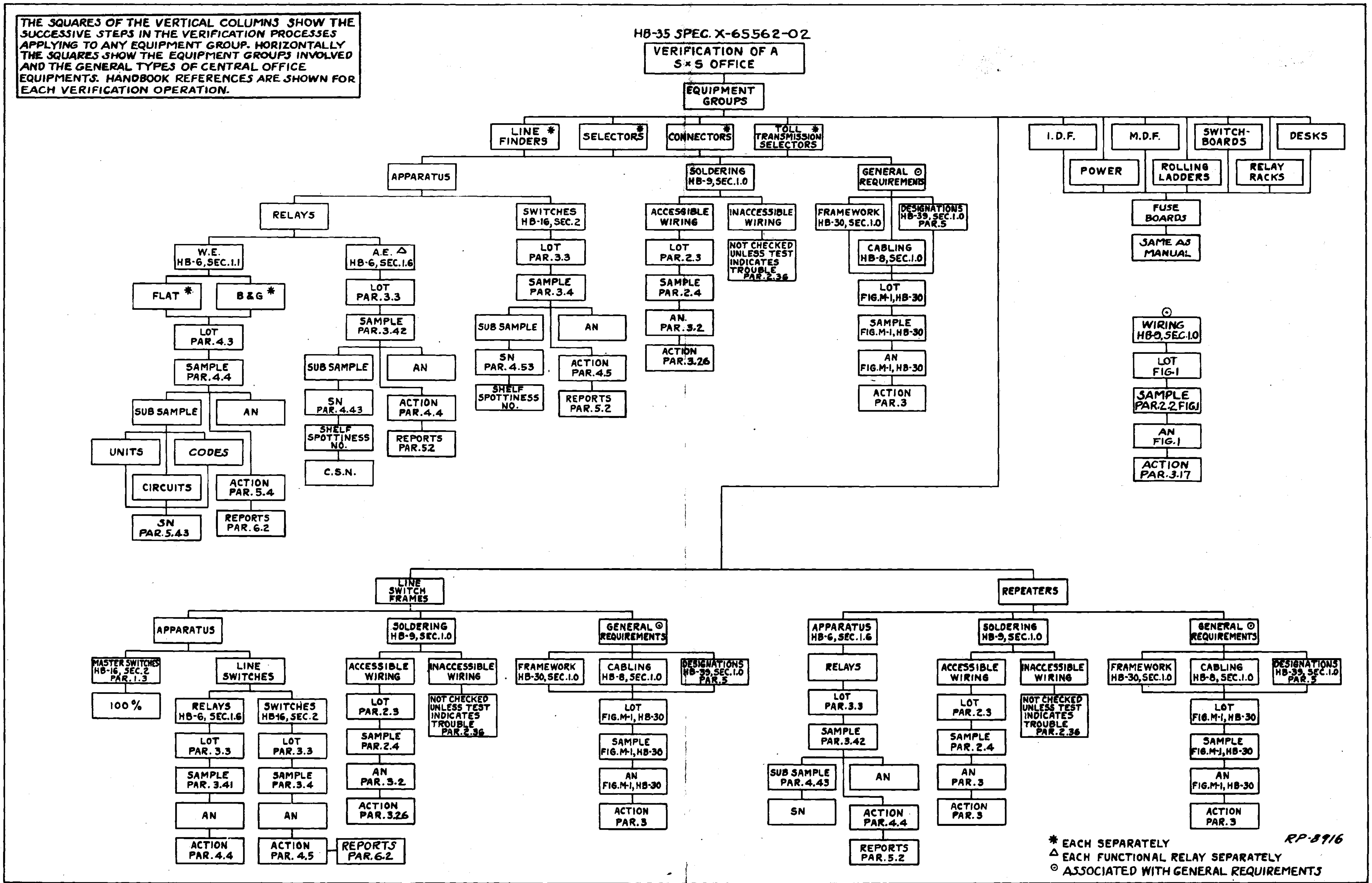


* EACH SEPARATELY
⊙ ASSOCIATED WITH GENERAL REQUIREMENTS

RP-8917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HB-35 SPEC. X-65562-02
VERIFICATION OF A S×S OFFICE
EQUIPMENT GROUPS
LINE FINDERS *
SELECTORS *
CONNECTORS *
TOLL TRANSMISSION SELECTORS *
I.D.F.
M.D.F.
SWITCH-BOARDS
DESKS
POWER
ROLLING LADDERS
RELAY RACKS
FUSE BOARDS
SAME AS MANUAL
APPARATUS
RELAYS
W.E. HB-6, SEC.1.1
FLAT *
B & G *
LOT PAR.4.3
SAMPLE PAR.4.4
SUB SAMPLE
AN
UNITS
CODES
CIRCUITS
ACTION PAR.5.4
SN PAR.5.43
REPORTS PAR.6.2
A.E. △ HB-6, SEC.1.6
LOT PAR.3.3
SAMPLE PAR.3.42
SUB SAMPLE
AN
SN PAR.4.43
ACTION PAR.4.4
SHELF SPOTTINESS NO.
REPORTS PAR.52
C.S.N.
SWITCHES HB-16, SEC.2
LOT PAR.3.3
SAMPLE PAR.3.4
SUB SAMPLE
AN
SN PAR.4.53
ACTION PAR.4.5
SHELF SPOTTINESS NO.
REPORTS PAR.5.2
SOLDERING HB-9, SEC.1.0
ACCESSIBLE WIRING
INACCESSIBLE WIRING
LOT PAR.2.3
NOT CHECKED UNLESS TEST INDICATES TROUBLE PAR.2.36
SAMPLE PAR.2.4
AN. PAR.3.2
ACTION PAR.3.26
GENERAL ⊙ REQUIREMENTS
FRAMEWORK HB-30, SEC.1.0
DESIGNATIONS HB-39, SEC.1.0 PAR.5
CABLING HB-8, SEC.1.0
LOT FIG.M-1, HB-30
SAMPLE FIG.M-1, HB-30
AN FIG.M-1, HB-30
ACTION PAR.3
⊙ WIRING HB-8, SEC.1.0
LOT FIG-1
SAMPLE PAR.2.2 FIG.1
AN FIG.1
ACTION PAR.3.17
LINE SWITCH FRAMES
APPARATUS
MASTER SWITCHES HB-16, SEC.2 PAR.1.3
100 %
LINE SWITCHES
RELAYS HB-6, SEC.1.6
LOT PAR.3.3
SAMPLE PAR.3.41
AN
ACTION PAR.4.4
SWITCHES HB-16, SEC.2
LOT PAR.3.3
SAMPLE PAR.3.4
AN
ACTION PAR.4.5
REPORTS PAR.6.2
SOLDERING HB-9, SEC.1.0
ACCESSIBLE WIRING
INACCESSIBLE WIRING
LOT PAR.2.3
NOT CHECKED UNLESS TEST INDICATES TROUBLE PAR.2.36
SAMPLE PAR.2.4
AN PAR.3.2
ACTION PAR.3.26
GENERAL ⊙ REQUIREMENTS
FRAMEWORK HB-30, SEC.1.0
CABLING HB-8, SEC.1.0
DESIGNATIONS HB-39, SEC.1.0 PAR.5
LOT FIG.M-1, HB-30
SAMPLE FIG.M-1, HB-30
AN FIG.M-1, HB-30
ACTION PAR.3
REPEATERS
APPARATUS HB-6, SEC.1.6
RELAYS
LOT PAR.3.3
SAMPLE PAR.3.42
SUB SAMPLE PAR.4.43
AN
SN
ACTION PAR.4.4
REPORTS PAR.5.2
SOLDERING HB-9, SEC.1.0
ACCESSIBLE WIRING
INACCESSIBLE WIRING
LOT PAR.2.3
NOT CHECKED UNLESS TEST INDICATES TROUBLE PAR.2.36
SAMPLE PAR.2.4
AN PAR.3
ACTION PAR.3
GENERAL ⊙ REQUIREMENTS
FRAMEWORK HB-30, SEC.1.0
CABLING HB-8, SEC.1.0
DESIGNATIONS HB-39, SEC.1.0 PAR.5
LOT FIG.M-1, HB-30
SAMPLE FIG.M-1, HB-30
AN FIG.M-1, HB-30
ACTION PAR.3
* EACH SEPARATELY
△ EACH FUNCTIONAL RELAY SEPARATELY
⊙ ASSOCIATED WITH GENERAL REQUIREMENTS
RP-8916

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HB-35 SPEC. X-65563-02

VERIFICATION OF A MANUAL OFFICE