HARDENING OF CENTRAL OFFICE AND MAIN STATION COMMUNICATION EQUIPMENT INSTALLED IN 10-PSI BUILDINGS GENERAL EQUIPMENT REQUIREMENTS

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1. GENERAL

A. Scope

1.01 This section covers the general equipment requirements for hardening central office and main station (such as carrier terminal) communication equipment to provide a communications installation capable of withstanding shock environment of 10 psi resulting from nuclear explosions. Installations that have been engineered to meet prescribed requirements during and after such exposure are said to be "10-psi hard" or to have been "hardened to 10 psi."

(a) All equipment installed in 10-psi buildings shall be hardened in accordance with this section even though the equipment may be considered nonessential to the hardened communication system.

(b) Equipment hardened in accordance with this section also satisfies the requirements for installing in earthquake areas.

(c) General equipment requirements for hardening of central office and main station communication equipment installed in 50-psi buildings are covered in Section 800-610-157.

(d) General equipment requirements for hardening of intermediate or auxiliary station communication equipment are covered in Section 800-610-160.

1.02 The requirements covered in this section shall be followed, except as modified by applicable specifications and drawings.

B. Building Construction

1.03 The hardening requirements covered herein are based on the assumption that the equipment will be installed in special underground buildings which have been designed to withstand an atmosphere overpressure pulse of 10 psi resulting from a nuclear explosion.

1.04 The building design criteria, including EMP protection, for 10-psi buildings is covered in X-76071.

1.05 ***The ceilings of 10-psi buildings*** are provided with either embedded ceiling channels or keystone decking in accordance with ED-97724-10 as follows:

(a) ***Embedded Ceiling Channels:*** Continuous channel inserts are embedded in the reinforced concrete ceiling in parallel rows and extend over all the equipment area. The embedded ceiling channel rows are dimensioned from the lines of building column centers which are 18 feet 6 inches apart. The exterior rows in a building are on the column center lines with the adjacent rows spaced 3 feet 9 inches inside the column center lines and the remaining two rows spaced at 3-foot 8-inch intervals. Rows of embedded ceiling channel inserts are similarly spaced over the areas between column lines and the walls of the equipment room. In all instances the embedded ceiling channel rows extend to the equipment room walls. The maximum allowable load at any one point on embedded ceiling channel is 2000 pounds. Where two or more loads are within 24 inches of each other, the safe working load is 2000 pounds totally for the group of loads. These loads are dead weight loads. The margin of safety is more than sufficient to include dynamic effects caused by building motions.

(b) ***Keystone Decking:*** Equipment room walls and ceilings are provided with steel decking having parallel rows of triangular shaped ribs which are embedded in the concrete. The ribs form a pattern of continuous inserts on 6-inch spacing. The KS-20509 keybolt hanger is used for attaching to the decking and provides a coupling nut to permit fastening a 5/8-11 threaded rod to the 1/2-inch keybolt. The safe working load for the keybolt hanger and decking is 2000 pounds. Where two or more loads are within 24 inches of each other, the safe working load is 2000 pounds totally for the group of loads. These loads are dead weight loads. The margin of safety is more than sufficient to include dynamic effects caused by building motions.

C. Basic Principles

1.06 ***Shock levels at 10-psi sites*** are low enough so that the hardened equipment units (including such items as mounting plates, panels, and relay rack units) within the equipment bays, which are designed to withstand direct vibratory accelerations up to 3G, do not require shock isolation.

1.07 ***In the switching equipment area,*** the bay frameworks, auxiliary framing, and cable racks are rigidly fastened to each other and to the floor, walls, and columns, and ceiling as shown on ED-97724-10.

1.08 ***In the power area,*** the power bay frameworks are floor supported.

1.09 ***Power cable racks, bus bars, and lighting fixtures*** are supported by a superstructure arrangement as shown on ED-82433-10.

1.10 ***In early 10-psi installation,*** the auxiliary framing in the power area was suspended from the ceiling and free floating, that is, not braced to walls, columns, or ceiling (see ED-97713-10). The cable racks, bus bars, and lighting were supported from this framing. This type of installation is now rated A&M Only.

1.11 ***Battery strings of tank cells*** are grouped together on floor plates as shown on ED-82219-51. Other types of batteries such as engine start and smaller types are mounted on battery racks, as shown on ED-82099-73.

1.12 ***Bus bars*** over the 302 power board are supported from auxiliary framing which is fastened to the tops of the cabinets as shown on ED-82264-11.

2. DESIGN CONSIDERATIONS

A. Basic Criteria

2.01 The object of hardening individual equipment units is to enable them to withstand a direct transient input of 3G peak acceleration without shock mounting. The performance criteria which hardened equipment shall meet when subjected to this shock are as follows.

(a) The equipment shall suffer no physical damage.

(b) Established connections shall remain intact, but momentary interruptions of the transmission path due to vibration of components, chattering of relay contacts, etc, will be permissible during the period of shock. Continuity of normal switching operations will not apply to connections which are in the process of being established during the shock period.

(c) The equipment shall be capable of functioning subsequent to the period of shock without manual reset.

2.02 Equipment, when mounted, shall not exceed 150-psf static load. The building structure has been designed to include the dynamic loads.

2.03 Electrical, duct, and pipe connections to equipment shall operate satisfactorily after the shock period.

B. Modification of Apparatus and Wiring

2.04 Standard equipment and apparatus that is to be specified for use in hardened applications should be investigated to ascertain its capability of meeting the requirements specified in 2.01.

2.05 Tests have been made on a wide and representative variety of apparatus and equipment codes to determine the severity levels required to cause failure in operation and permanent physical damage. These tests show that the fragility level of Bell System equipment varies from about 1G to at least 20G.

2.06 Most equipment units will require some modification but standard communication equipment and apparatus that can ordinarily be shipped safely without special or unusual packing precautions will in general need a relatively small number of comparatively simple changes to achieve the 3G fragility level required for use in hardened installations.

2.07 When modification of an existing design of unit is required to make the unit suitable for use in hardened installations and will not be required for normal use, the modification shall be covered by a list added to the J code. The list shall require stamping 3GHDN in close proximity to the stamped J code. The list shall be worded, "Equipment and assembly required in addition to List to meet the requirements of BSP Sections 800-610-157 and 800-610-163."

2.08 When an existing design has been shown to meet the requirements of this section or a new unit has been designed to meet them, the unit need not be stamped. An engineering note to which reference is made for any code falling into this classification shall be added to the covering specification, reading as follows. "This unit, as manufactured, meets the requirements of BSP Sections 800-610-157 and 800-610-163."

2.09 It is not practicable to list all of the modifications that may be required to strengthen equipment units and apparatus so that they will be suitable for use in hardened applications. However, the following list of the most frequently required modifications should serve as a guide to the general type of modification likely to be required. The modifications in the following list shall be incorporated wherever applicable in the manufacturing information for all hardened equipment units or apparatus.

(a) Plug-in or snap-on type apparatus or covers, other than electron tubes having positively locked shields, shall be secured by adequate holding clamps.

(b) Pigtail-connected electronic parts which either exceed 1/2-ounce weight or have leads greater than 1 inch shall be given adequate independent mechanical support to prevent lead breakage. This can be accomplished by mounting on cards or by use of brackets or clips as follows.

BRACKET	USED WITH
P-40H709	Individually mounted U- or Y-type relays
P-40H710	280- or B-type relays
P-41N399	Wire-spring relays
P-44V760	Y-type relays
P-44V814	B-type relays

CLIP	USED WITH
P-263678	Nonrelay apparatus and relays where only one mounting hole is available

(c) Replace fragile apparatus items with more rugged designs. Other things being equal, use the lightest weight item available. In doubtful cases, consult the appropriate apparatus development organization for suitable apparatus codes.

(d) Add cable form bracing to reinforce unsupported cable arms such as those feeding jack fields in accordance with Section 800-612-156 and ED-64578-30.

(e) Replace mounting plate piece parts having open-end notches for the mounting screws with mounting plates having holes or closed-end slots.

(f) Where transformers or other relatively heavy pieces of apparatus are mounted near the center of panels, steps shall be taken to adequately strengthen the panel or independently support the heavy part.

C. Hardness Test Specification, X-76048

2.10 ***All WE supplied equipment*** in hardened 10-psi main stations shall be capable of surviving the appropriate test or tests as specified in X-76048.

3. REQUIREMENTS

COMMON REQUIREMENTS

A. Support of Pigtail-Connected Electronic Parts

3.01 Where pigtail-connected electronic parts such as capacitors, coils, 185A or 186A networks, resistors, etc, are supported on brackets or clips (see 3.02) to prevent lead breakage, they shall be secured to the bracket or clip as shown in Fig. 1 and 2 (brackets) or Fig. 3 (clips).

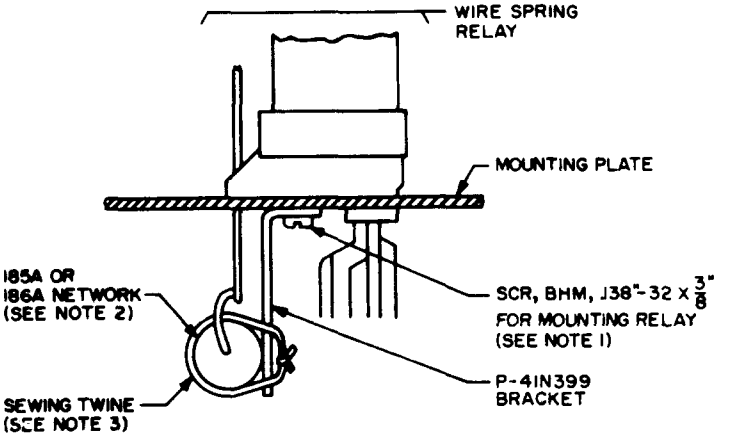
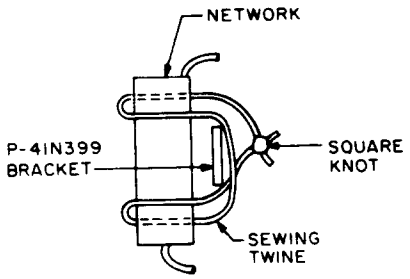


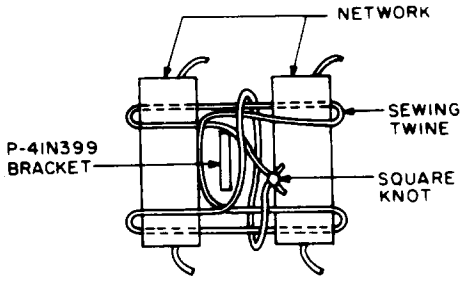
Fig. 1—Support of Pigtail-Connected Electronic Parts—185A or 186A Network Shown



REAR VIEW

ONE NETWORK
PARALLEL TO MOUNTING PLATE

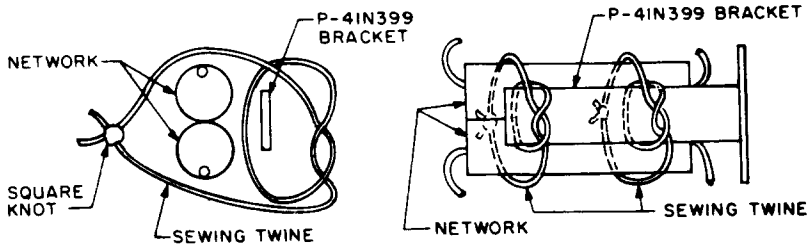
FIG. A



REAR VIEW

TWO NETWORKS
PARALLEL TO MOUNTING PLATE

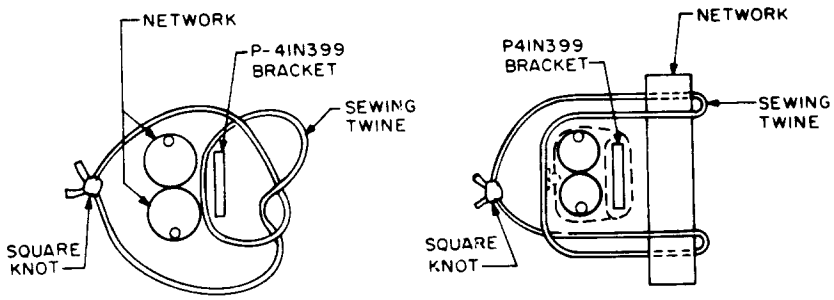
FIG. B



REAR VIEW SIDE VIEW

TWO NETWORKS
PERPENDICULAR TO MOUNTING PLATE

FIG. C



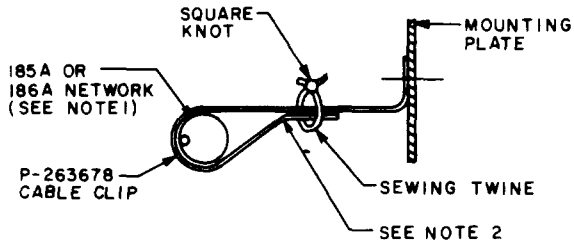
STEP 1
(SEE FIG. C)

STEP 2

THREE NETWORKS
TWO PERPENDICULAR AND ONE PARALLEL
TO MOUNTING PLATE

FIG. D

Fig. 2—Method of Tying Pigtail-Connected Electronic Parts to Brackets—185A or 186A Network and P-41N399 Bracket Shown



NOTES:

1. PROTECT BODY OF NETWORK WITH LAYER OF ACETATE FIBER TAPE BEFORE MOUNTING IN CABLE CLIP.
2. BEND CABLE CLIP APPROXIMATELY AS SHOWN BEFORE TYING.

Fig. 3—Support of Pigtail-Connected Electronic Parts—Only One Mounting Hole Available for Support Detail—185A or 186A Network Shown

3.02 The following brackets or clip shall be used for supporting pigtail-connected electronic parts.

BRACKET	USED WITH
P-40H709	Individually mounted U- or Y-type relays
P-40H710	280- or B-type relays
P-41N399	Wire-spring relays
P-44V760	Y-type relays
P-44V814	B-type relays

CLIP	USED WITH
P-263678	Nonrelay apparatus and relays where only one mounting hole is available

3.03 Brackets shall be mounted with longer relay mounting screws when mounting relays as follows.

RELAY	BHM SCREW
Wire spring	0.138" — 32 X 3/8"
B, U, or Y type	0.164" — 36 X 15/32"
280 type	0.138" — 32 X 7/16"

3.04 Body of 185A or 186A network shall be protected with one layer of acetate fiber tape (or commerically available transparent tape) or clear plastic tubing (7/16-inch Irvolite, 25-mill wall) before tying to bracket.

3.05 Electronic part shall be secured to bracket with sewing twine, as shown in Fig. 2, before connecting to relay terminals.

B. Single and Multiplate Equipment Units Using 178A or 189A Mounting Plates

3.06 ***Single mounting plate units*** of 178A or 189A mounting plates shall be fastened to the frame uprights with four screws.

3.07 ***Multiplate Equipment Units:*** Where multiplate equipment units consisting of two to five 178A or 189A mounting plates are assembled using P-44J074 and P-44J075 mounting plate clips, apparatus such as relays, terminal strips, etc, mounted on these mounting plates shall not be closer than 1 inch to the ends of the plates. The multiplate units shall be mounted on frames in accordance with ED-27723-01 with a minimum of $2n + 2$ mounting screws, where n is the number of mounting plates in the unit. Four screws are required in the bottom mounting plate and two screws in the upper holes of the top mounting plate. All interior mounting plates require two screws each, one in each end, and preferably in the top hole. This requirement applies to both shop-mounted units and units that are shipped separately and mounted on frames by the installer.

INSTALLATION REQUIREMENTS

C. Switching Equipment Area

3.08 ***Equipment bays*** shall be fastened to the floor and supported by auxiliary framing in accordance with ED-97724-10.

3.09 ***Low-type auxiliary framing and ladder-type cable racks*** shall be installed in accordance with ED-97724-10 as follows:

(a) Column braces and ceiling braces between columns shall be provided.

(b) Wall braces shall be applied to those two outside walls which parallel the bay lineups.

(c) Where walls are nonload bearing, ceiling braces per Section 800-610-155, Fig. 2A shall be used at a point close to the nonload bearing wall or at the growing end of the framing.

3.10 ***Lighting*** shall be installed in accordance with ED-81704-10 and ED-81705-10.

D. Power Equipment Area

3.11 ***Power bay frameworks*** shall be fastened to the floor using floor bolts in every hole in the frame bases which have been provided for fastening. Frames shall be leveled by means of shims. Leveling screws shall not be used.

3.12 ***Cabinet-type power equipment*** shall be fastened to the floor using base reinforcing details in accordance with ED-82368-50.

3.13 ***Floor-mounted KS-20048 battery cells*** shall be fastened to floor plates in accordance with ED-82219-51.

3.14 ***4-Row 2-tier battery stands*** for KS-20106 battery cells shall be fastened to the floor in accordance with ED-82099-73.

3.15 ***Early 10-psi Installations:*** The following requirements [3.15 (a) through 3.15 (i)] pertain to early 10-psi installations where the auxiliary framing in the power area was suspended from the ceiling and free floating. These requirements [marked by a dagger (†)] are now rated A&M Only and superseded by 3.16 through 3.30.

(a) †***Auxiliary Framing—Ceiling Suspended:*** Auxiliary framing shall be supported from ceiling in accordance with ED-97713-10 and shall be a minimum of 3 feet 0 inch below the ceiling line. It shall be free floating and no bracing shall be provided to walls, columns, or ceiling. A 6-inch clearance shall be provided between the auxiliary framing and walls, columns, or objects which are rigid to the building. A 6-inch horizontal separation shall be maintained between the framing of this area and that of other areas of the building.

(b) †***Cable Racks:*** No solid connections shall be made between the power area cable racks and the equipment area cable racks or the power equipment bays. A 6-inch horizontal separation shall be provided between the ironwork of the power area and the equipment area.

(c) †***Power Cabling:*** Power cables shall be provided with 1 foot of slack to permit 6 inches of horizontal motion as they transfer from the power area cable racks to the power equipment and between the power area and equipment area.

(d) †***Power Wiring:*** All power wiring shall be the same as that specified for a 50-psi installation in accordance with Section 800-610-157. The flexible cable arrangements between the bus bar assemblies over the batteries and power boards shall be KS-20123 type as shown on ED-82264-30.

(e) †***Spring Hangers:*** Spring hanger cable rack support shall be provided for the distribution leads from the 302 power plant CTS in accordance with ED-82274-11.

(f) †***Auxiliary Framing—Square D Duct:*** A 6-inch separation shall be maintained between the auxiliary framing used to support the square D duct and the auxiliary framing used to support the cable racks and bus bars in the power area.

(g) †***Conduits:*** All conduit running between the floating cable rack structure and rigidly-mounted equipment, including the equipment area auxiliary framing, shall be provided with a 1-foot flexible section to permit 6 inches of horizontal movement. Conduit such as the power runs from the ac switch gear may be run hard-mounted to the ceiling using a flexible

section to drop into the equipment in the power area.

(h) †***Bus Bar Extensions Within Power Bays:*** Since the floating cable racks and auxiliary framing must be kept separated from the power equipment bays, bus bar extensions within the power bay lineup shall not be suspended from the auxiliary framing; unequipped bays shall be added to fill gaps in a lineup for support of the bus bars.

(i) †***Over-Frame Bus Bars:*** In order to make a more rigid structure of the bus bars which are supported on the free floating superstructure, the bus bars shall be sandwiched between auxiliary framing placed both above and below the bars. A mid-aisle support shall also be provided in all cases for the bus bar run between the power board line and the rectifier line as shown on ED-82264-30, Fig. 4B. Since the auxiliary framing over these lineups is at different levels, braces per Section 800-614-156, Fig. 16A shall be used at the connecting point of the two levels. (See ED-82264-30, Section G-G, sheet 4.)

(j) †***Insulators:*** Bus bars shall be supported with insulators as shown on ED-82264-30.

(k) †***Engine Room:*** Engines and turbines shall be provided with rigid fastenings and installed in accordance with the standard drawing applicable to the specific engine or turbine employed. (See EIM 6720.)

(1) Ceiling supported material shall be installed using earthquake bracing in accordance with Section 800-610-155.

(2) Wall- and column-supported material shall be installed in accordance with ED-97710-10.

(3) Engine start battery stand shall be in accordance with ED-82409-70.

(l) †***Miscellaneous Wall-Mounted Equipment:*** Alarm panels and miscellaneous wall-mounted equipment shall be mounted to walls and columns in accordance with ED-97710-10. Small conduits and switch boxes may be secured directly to walls and partitions. [See 3.15 (g).]

3.16 ***Superstructure*** for supporting power cable racks, bus bars, and lighting fixtures shall be installed in accordance with ED-82433-10.

3.17 ***Power wiring*** shall be provided with more flexible stranding in accordance with Table A. This cable is not identified in any manner different than the standard. The strands must be observed in order to verify the type.

TABLE A

WIRE SIZE	SEE NOTE	WIRE TYPES	NO. OF STRANDS
14 to 2	1, 2	KS-5482-01 with class B stranding	7
0 to 0000		KS-5482-01 with class C stranding	37
350 & 500 MCM		KS-5482-01 with class D stranding	91
750 MCM up		KS-5482-01 with class D stranding	127

Notes

1. Since 14-, 12-, and 10-gauge wire are normally furnished as solid wire, it will be necessary to specify B stranding.

2. Eight gauge to 2 gauge is normally provided as class B stranded.

3.18 ***The flexible cable*** arrangements between the bus bar assemblies over batteries and power boards shall be KS-20123 type as shown on ED-82264-11.

3.19 ***Conduit*** for KS-15992 and KS-19896 gas turbine alternators shall be installed in accordance with ED-82119-30 and ED-82281-30, respectively.

3.20 ***Bus Bar Extensions Above Rectifier Bays:*** Bus bar extensions above the rectifier lineup shall be supported from the framing placed on the tops of the rectifier bay frameworks as shown on ED-82264-11. Support shall be provided by adding unequipped bays where there are gaps in the lineup.

(a) In offices where ED-82433-10 has been applied, the bus bar extensions shall be supported on the superstructure and unequipped bays are not required for gaps in lineup.

3.21 ***Over-Frame Bus Bars:*** Bus bars over power board or rectifier lineups shall be supported on auxiliary framing which shall be fastened to the tops of the bay frameworks. The bus bar runs between the power board and rectifier lineups shall be provided with mid-aisle support as shown on ED-82264-11. Since the auxiliary framing over these lineups is at different levels, bracing per Section 800-610-155, Fig. 16A, shall be provided between the two levels (see ED-82264-11).

3.22 ***The bus bars over the batteries*** shall be supported on the auxiliary framing and shall be sandwiched between auxiliary framing placed above and below the bus bars as shown on ED-82264-11.

3.23 ***Insulators:*** Bus bars shall be supported with insulators as shown on ED-82264-11.

3.24 ***Engine Room:*** Engines and turbines shall be installed in accordance with standard drawing applicable to the specific engine or turbine provided.

3.25 ***Ceiling supported material*** in the engine room shall be provided with earthquake bracing in accordance with Section 800-610-155.

3.26 ***Wall- and column-supported material*** in the engine room shall be installed in accordance with ED-97710-10.

3.27 ***The engine start battery stand*** for 200KW gas turbine shall be installed in accordance with ED-82409-70.

3.28 ***Miscellaneous Wall-Mounted Equipment:*** Alarm panels and miscellaneous equipment shall be mounted to walls and columns in accordance with ED-97710-10.

3.29 ***302B power plants*** shall be installed in accordance with ED-82264-11.