RECONDITIONING CENTRAL OFFICE AND PBX EQUIPMENT DAMAGED BY WATER

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1. GENERAL

1.01 This section provides general recommended procedures in the event of a water damage emergency in a central office or PBX. Detailed procedures for assembly, disassembly, or adjustment of apparatus is covered by sections on the particular apparatus involved.

1.02 Water damage to buildings, central office, and PBX equipment may result from a variety of different causes. Among them are floods, defective plumbing, rain or snow entering windows, ventilation or temporary building openings, fire fighting efforts, etc.

1.03 Restoration of water-damaged central office and PBX equipment is a matter calling for the closest cooperation among departments.

1.04 It is suggested that those who would supervise or otherwise participate in restoration work be familiar with information in these notes and local disaster plans so that service interruptions due to emergencies may be minimized as much as possible.

1.05 The importance of thorough planning cannot be overemphasized. Thorough planning and organization at the out set of a water-damage emergency can materially reduce the time required to restore service.

1.06 Section 167-790-811, Reconditioning Telephone Power Plant Equipment After Water Damage, carries specific information relative to the reconditioning of telephone power plant equipment after water damage by the central office emergency procedures.

2. ACTION AT OFFICE OR PBX WHERE WATER DAMAGE THREATENS

2.01 There are a number of local administrative steps that should be taken well before a flood threatens to hit. Vulnerability of all central offices should be appraised. Results of the appraisal will indicate priority and the extent of administrative planning needed. Experience suggests that the appraisal and the preparation of a detailed plan for each office be the responsibility of the office supervisor, together with the plant staff and engineering people. the following should be considered in making detailed emergency plans:

(1) Organization chart to show individual responsibilities during emergency—including

those to be kept advised on the emergency status of the central office

(2) Current call-out list of employees and supervisors, together with an alternative list.

(3) Trained operators for emergency switchboards

(4) Radio to check flood developments.

(5) Procedure for allocating equipment necessary for flood control.

(6) Contour map of the surrounding area showing the best access routes.

(7) Employee instruction to take office records to safety if a flood threatens. Posted memorandum notices may help.

2.02 Primary and alternate sources of material and equipment should be known. Some of the needs will be:

(1) Sandbags and barricades

(2) Boats

(3) Water pumps

(4) Emergency power equipment

(5) Boots, buckets, mops, brooms and hoses

(6) Heat lamps, fans, nylon bristle brushes of various sizes, hair dryers, blowers, etc

(7) Clean fresh water for flushing equipment. Some pumping facilities may be needed to force water to equipment locations. Some tank trucks are not equipped with pumps. Pressure on the order of 25 lb. per sq. in.—"garden hose" pressure—will be required.

(8) Food, drinking water, blankets, etc.

(9) Transportation for material and people.

(10) Where an office is in a potential flood area, standing arrangements may be made with local tank truck operators and/or the fire department to supply clean water when needed. Similar arrangements may also be made for engine driven arc welding sets, etc. It is suggested that a list of the firms involved be maintained at both the local and district offices.

2.03 The basic plan may need periodic review to be continuously applicable. If properly applied this plan should ensure efficient use of manpower and material in these emergencies.

2.04 *All possible steps should be taken to prevent water from entering buildings. This includes sandbagging, use of plank barricades, if provided, and any improvised means that might be effective.*

2.05 *If it becomes necessary to abandon a central office or a PBX to rising water, it is extremely important to de-energize the equipment before contact with water. This is to prevent damage to both switching and power equipment due to electrolytic corrosion.* As many of the following steps as possible should be taken, in the order of preference indicated, before an office is abandoned.

(1) Remove all main discharge and associated alarm fuses.

(2) Remove battery charging and associated alarm fuses from power plant rectifiers.

(3) If an office is equipped with an automatic start emergency engine generator, disable the automatic start feature to prevent starting when (4) is done.

(4) Disconnect a-c feed to power plant charging equipment.

(5) Fill the batteries to the top with clear tap water—this will help exclude contaminated water from the cells.

Note: A list of appropriate local instructions may be placed in a conspicuous place to cover the previous operations in offices vulnerable to flooding.

2.06 Office drawings, assignment records, cable books, and line cards are extremely valuable records. Every reasonable effort should be made to move them to a location above likely water levels.

3. HEADQUARTERS ACTION

3.01 *Initial appraisal of damage to equipment to determine whether reconditioning is possible or replacement is necessary is probably the most critical phase of the service restoration effort.* The appraisal should be thorough. It should usually be made, as early as possible, by a team of experienced plant and engineering people.

A. Developing Restoration Plans

3.02 While the damage appraisal is being made, various service restoration alternatives should be explored. Among the items for which plans should be made are:

(1) Provision for urgently needed toll circuit connections to points outside the disaster area. Magneto toll stations may be used for outgoing calls.

(2) Provision of emergency service to vital organizations such as the military, civil defense, fire and police departments, hospitals, etc. Mobile radio, PBX switchboards, manual switching equipment, telephones located in strategically placed outdoor booths, etc, may often be used to good advantage to quickly establish vital communications for essential organizations and for emergency public use.

(3) Provision for replacing equipment in case the inundated equipment is irreparably damaged and can not be reconditioned. In extreme cases service may be reestablished by use of temporarily installed manual switchboard or mobile CDO equipment until the damaged equipment can be reconditioned.

(4) Provision of an adequate personnel force to recondition the central office or PBX equipment.

(5) Provision of water, food, and shelter for those working in the flood area.

3.03 Civil defense windshield stickers, permits, etc will be required to gain entry to most disaster areas.

B. Providing Emergency Equipment and Supplies

3.04 To reduce restoration time, an area equipment availability survey should be made. Thus, equipment that may be used if necessary in a water-damaged office or PBX can be spotted for quick shipment. The survey should include a review of spare equipment in working offices, equipment being installed, or in transit that may be diverted to damaged offices or PBXs, mobile manual or step-by-step equipment, equipment held in storage in the area or at the distributing house, and that stored for emergency use.

3.05 It is suggested that shipments to emergency areas be addressed to a particular person and department. Shipments to "Telephone Company" are subject to delay while requisitions are checked.

3.06 New equipment required in addition to that from sources just enumerated should be ordered from the Western Electric Company on an emergency basis. It is essential that all equipment, cabling, apparatus, etc required be ordered as soon as specific needs are known or anticipated. Care should be taken in ordering to prevent overlooking miscellaneous items. Battery operated test equipment should be ordered complete with batteries.

3.07 Additional equipment which may be required includes emergency power equipment, heat lamps, psychrometers, thermometers, air compressors, hair dryers or equivalent, fans, and water supplies. Local contractors may be able to provide arc welding sets to recharge batteries and power generating equipment to operate heat lamps, fans, etc. Local contractors may also be able to pump water out of flooded buildings, clear out mud and debris, build frames for heat lamps, install temporary wiring, make emergency repairs to buildings, etc.

3.08 There are a number of tools not normally used in central offices that will be very useful in an office being reconditioned after a flood. These include: 6" and 8" adjustable wrenches, 7" lineman's pliers, various screwdrivers, hammers, etc.

3.09 An adequate number of 35- and 70-type fuses should be ordered since a number of them may operate during the course of restoration.

3.10 The wiring diagrams, schematic drawings, and circuit description sheets covering all equipment to be reconditioned, installed new or transferred from another location, should be sent to the damaged office or PBX for use' by installation and maintenance people.

3.11 One of the first orders placed on the Western Electric Company in water-damaged equipment cases might well be for additional copies of necessary office drawings and Bell System Practices for use both at headquarters and at the damaged office or PBX.

3.12 Test sets, test cabinets, tools, meters, etc are required in relatively large quantities during restoration work. Establishment of an area or company emergency stock of these items is a worthwhile insurance measure.

C. Alerting Western Electric Company and AT&TCo

3.13 The Western Electric Co. distributing house serving an area in which a water-damage emergency threatens or exists should be contacted so that necessary personnel may be made available to process emergency orders.

3.14 The Western Electric installation organization should be apprised of an emergency so that necessary installation forces may be dispatched as required to damaged offices.

3.15 The equipment and building engineer of the AT&TCo, O&E Department should be advised by usual engineering coordinators of an impending or existing major water-damage emergency, this in no way voids the customary plant emergency reporting plan.

4. EFFECTS OF WATER ON EQUIPMENT

4.01 *Corrosion:* Three forms of corrosion may be encountered on equipment subjected to flooding conditions.

(1) Electrolytic corrosion occurs when anodes and cathodes are present in an electrolyte as supplied by the flood water and a direct current flows as would occur when power is on.

(2) Chemical corrosion occurs when metal is exposed to moisture and does not require a current flow. This process is speeded up when the moisture contains salts such as those present in sea water and sometimes floodwater.

(3) Galvanic corrosion occurs when two dissimilar metals either in direct contact or connected electrically are exposed to an electrolyte. The current which flows in this case is similar to the action of a battery.

4.02 *Electrolytic Corrosion:* Energized equipment will be subject to electrolytic corrosion of metallic parts if exposed to excessive surface moisture. This corrosion may be regarded as an accelerated case of chemical corrosion. The corrosion products are salts of metal which generally form very quickly. They usually form in *intense concentrations.* The concentration of these products depends on time, potential, and the amount of salts in the flood water which acts as the electrolyte. Concentrations are greatest at points where current leaves metallic parts and less severe at other points on the same parts. Color of the products depends upon the metal being corroded. Anode conductors, those connected to the positive battery terminal are particularly subject to corrosion. But negative (cathode) conductors may not be visibly affected. When the electrolyte (moisture) and/or potential are removed, the electrolytic corrosion process generally stops. Severe electrolytic corrosion damages affected equipment beyond repair within minutes. Wire insulation, separators and other insulators become conductive because metallic ions are formed. Wire in relay and magnet coils is reduced in cross section and will likely result in an open when potential is applied. Generally, equipment seriously affected by electrolytic corrosion will have to be replaced.

4.03 *Chemical Corrosion:* This corrosion may generally be distinguished from electrolytic corrosion because products of electrolytic corrosion are much more uniform over the corroded surface. Corrosion without electrolytic action seldom is severe enough to be service-affecting. Zinc, commonly used as a finish for switch castings, mounting plates, etc is particularly subject to this condition. Whitish deposits, basic zinc carbonate, are often found on zinc-coated parts when they dry out.

4.04 *Galvanic Corrosion:* Corrosion products may form around noble metal contacts at the junction with base metal springs due to galvanic action. Examples of noble metal contacts are No. 1 metal, which is an alloy of gold, silver, and platinum and No. 2 metal which is palladium.

4.05 *Contact contaminations:* Base metal contacts are used on step-by-step banks, commutator segments, and commutator wipers.

This type of contact is also used on panel banks, sequence switches, selectors, etc. Unless electrolytic corrosion has occurred on base metal contacts, forcing replacement, normal cleaning procedures will generally be effective after water damage. Usual cleaning procedures will be effective to remove dirt, lint, and loose corrosion products lodging on noble metal contact surfaces. Removal of galvanic corrosion products around noble metal contacts is covered in 5.30.

4.06 *Swelling of Insulators, Panel Cork Rolls, etc:* Insulators, spool heads, panel cork rolls, and other materials containing fibrous fillers will swell as water is absorbed. They will partially or fully contract as they dry out. Loose spring pileups may result in some cases. Panel cork rolls will probably need to be replaced because they cannot quickly be dried to the point where they will contract to their original dimensions and remain free from warpage.

4.07 *Open Coil Windings:* Open relay and magnet coil windings may occur due to electrolytic corrosion when equipment is re-energized if moisture has not been sufficiently removed.

4.08 *Silt and Debris:* Flood water is generally heavy-laden with silt which is deposited as the water velocity is reduced. It usually contains fine binding particles of clay which are nearly impossible to remove from equipment by flushing if allowed to dry. Debris lodges in multiple wiring, cable forms, inside relay covers, etc. If it is not thoroughly removed, it will continuously sift out and produce contact contamination after the equipment is dried.

5. REMEDIAL ACTION AFTER WATER DAMAGE

A. General

5.01 Experience shows that water-damaged central office and PBX equipment can generally be reconditioned and reused without requiring subsequently increased maintenance effort provided that: (a) electrolytic corrosion did not occur to any appreciable extent, (b) equipment is promptly flushed with clean water, and (c) it is thoroughly dried out and cleaned before battery potential is again applied.

5.02 The decision of whether replacement is necessary in cases of electrolytic corrosion must be based on a judgment evaluation of the situation. For obvious reasons, no electrical measurements or operational tests should be attempted at this time. The criteria to be used in the evaluation are, therefore, entirely visual, subject to individual judgment, and cannot be easily defined. External evidence must be used as a guide to predict seriousness of internal damage to relay and magnet coils and various insulation materials. The following may help to make the restoration versus replacement decision.

(1) It is important to distinguish between electrolytic corrosion, and the relatively harmless non-electrolytic or chemical corrosion. Commonly used nickel-silver and brass contact springs are not likely to be easily corroded by short exposure to water in the absence of electrical potentials, whereas zinc-coated parts, such as switch castings and mounting plates, are relatively susceptible to this type of corrosion. Therefore, nickel-silver and brass springs provide the best indicators of electrolytic corrosion. If there are concentrated bluish-green deposits on these metals, particularly at spring pileups, electrolytic corrosion is probable. Non-electrolytic corrosion products are most often distributed over larger areas somewhat uniformly. They should, if possible, be removed before equipment is restored to service to prevent contact contamination, but are not otherwise harmful.

(2) As stated before, severity of electrolytic corrosion will vary with (a) the duration of time that potential remains on equipment during the flood, or later if it is again applied while the equipment is still damp, and (b) the amount and kinds of salts in the water that can form electrolyte. It, therefore, bears repeating that whenever possible, potential be removed before flooding occurs. Probabilities of whether potential remained on the equipment during flooding, and if so, as precise knowledge of the duration as possible will be of help in differentiating between electrolytic and non-electrolytic corrosion.

(3) Equipment with only slight, scattered evidence of electrolytic corrosion products can generally be reconditioned without danger of excessive relay and magnet coil open circuit conditions or insulation failures. Where concentrated corrosion products are observed generally on nickel-silver and/or brass springs, or where spring metals or wires have begun to erode, the reconditioning

stage is passed and the affected equipment must be replaced.

(4) Those without previous flood experience must resist a strong temptation to replace flooded equipment solely on the basis of its appearance when water first recedes. Mud, silt, debris, and general disorder are ***not*** the damage criteria on which the replacement-restoration decision is based. The basic criterion is the degree of electrolytic corrosion that has occurred.

(5) There obviously will be times when qualified appraisers cannot quickly reach flooded offices to decide whether reconditioning is a good risk. In such an event, the local plant supervisor must decide upon immediate steps. Of course, he will be able to easily tell if there is no electrolytic corrosion or if it is severe. If there is no such corrosion, restoration procedures covered in the following statements should be started at once. If electrolytic corrosion is severe, general "housecleaning" should be done to prepare for replacement of the damaged equipment. When there is reasonable doubt about the degree of damage, the local supervisor should contact line or staff people to seek their advice. If the reconditioning versus replacement decision is to be deferred until qualified appraisers arrive, only general "housecleaning" should be started. On the other hand, it may be advisable to attempt minimizing outage time in these marginal cases by starting restoration procedures without waiting for an appraisal. The advantage of such action is apparent where damage proves minor. The penalty for reconditioning equipment that should have been replaced lies in piecemeal replacement of components such as relay and magnet coils. Further, it should be recognized that flushing and cleaning the equipment will very likely destroy external clues to internal damage. Therefore, appraisers arriving after reconditioning is well under way cannot evaluate the degree of damage as accurately as they otherwise could.

5.03 Because of road or other conditions, a few cases have occurred where access to water-damaged offices and PBXs has been impossible for extended periods. In some of these cases, the equipment had become quite thoroughly dried out by the time attention could be given to it. In order to quickly restore service, the equipment was not flushed off with water, but it was "dry cleaned" by means of brushes, vacuum cleaners, etc. It is recognized that this procedure involves a certain amount of calculated risk. It is not possible, with dry cleaning techniques just mentioned, to completely remove the fine binding clay deposits that adhere to the equipment. These deposits may contain salts that will, after equipment is re-energized, permit electrolytic corrosion or electrical leakage during high humidity periods. Therefore, it appears prudent to make visual inspections of such equipment at intervals during high humidity periods for evidence of electrolytic corrosion. These inspections should be supplemented by insulation resistance measurements to help detect deterioration due to this possible cause.

5.04 Experience suggests that crossbar equipment subjected to excessive moisture can be reconditioned. It should be expected, however, that the few open relay coils that must be anticipated where water damage occurs probably would have a more serious effect in the crossbar systems than in others.

5.05 The general plan found effective in past emergencies for promptly reconditioning water-damaged central office and PBX equipment not judged to be seriously affected by electrolytic corrosion is as follows:

(1) Flush mud and debris off equipment with clean water aided by brushing.

(2) Drive off surface moisture with compressed air.

(3) Dry the equipment out using warm air and fans to prevent hot spots.

(4) Pressure-clean equipment to remove residual silt and debris.

(5) Clean electrical contacts and contact surfaces.

(6) Lubricate mechanical equipment where necessary.

(7) Make operational tests.

(8) Place equipment back into service.

(9) Make periodic "post-cutover" inspections for reasonable period.

5.06 Office records, if destroyed, may be reconstructed by consulting the various headquarters records, appropriate microfilms, if available, etc.

B. Central Office and PBX Equipment

Flushing and Related Operations

5.07 As water recedes or is pumped from the building, the first step is to set up a clean water distribution system and flush off the equipment. Do not remove equipment covers at this time. *Flushing should be started as soon as possible* for two reasons: (a) to clean equipment of mud while it is still in the semi-fluid state, and (b) to remove absorbed salts from insulation material that might otherwise later result in electrolytic corrosion during high humidity periods. Mud, particularly that containing clay, is much more difficult to remove when it is permitted to dry on the equipment. Begin the flushing operation at the high water mark and work downward to remove silt and debris. After equipment has once been soaked, flushing can do it no further harm. Care should be taken not to dampen equipment which has not been subjected to water damage. The force of the water spray should be no stronger than required to remove the silt and debris.

5.08 After a cycle of flushing is completed, remove equipment covers, open up sewn cable forms, bank multiples, switchboard cables, etc as far up as they appear wet or a foot above the high water level, whichever is greater. In one instance, vertical runs of new plastic covered switchboard cables were dried out without being slit open. A small slit was cut in the sheath about a foot above the high water line. Then the small nozzle of an air compressor was inserted in the slit. Moisture was blown out the lower end of the cable. In view of this very limited experience, no general recommendation of the method can yet be made.

5.09 Again flush equipment down in order to remove remaining sand, silt, and debris. Then use a hose and nozzle to dislodge the harder-to-remove particles. Care should be taken to direct the stream to both upper and lower sides of terminal strips, banks, etc.

5.10 If equipment quantities are relatively small, it may be desirable to remove dismountable equipment from the frames for flushing, cleaning, and drying. Tag the equipment to facilitate returning it to the location from which it was removed.

> *Caution: Use of rust inhibitors is not recommended since they may leave gummy deposits on relay parts, such as backstops, and interfere with operation.*

5.11 Right after flushing is completed, surface moisture remaining should be removed with air compressor sets. This can be started on upper equipment while that below is still being flushed. It may be necessary to use dry cleaning cloths to remove some of the moisture. These items should preferably be of the type commonly used in central offices. Start at the high water mark and work downward.

5.12 While equipment is being flushed, the equipment room floor should be cleaned and mopped. Mopping may be required on a continuous basis during restoration. Despite all efforts to control it, silt will be carried into the office on the shoes of those entering the building.

Drying Operations

5.13 Some telephone apparatus can be dried out sufficiently for service in 24 hours; practically all of it can be dried in 72 hours.

5.14 Apparatus and wiring forms will dry more quickly if opened sufficiently to allow free circulation of air.

5.15 The paragraphs immediately following include suggested means to hasten drying of dampened equipment by evaporating moisture into the air and exhausting it out of the building. As is well known, the ability of air to carry moisture is increased by raising its temperature. As an aid in maintaining optimum absorptive capacity of the air during the drying operation (a) its temperature should be raised to the highest level consistent with personnel safety, and (b) regardless of the temperature, movement of outside air through the office should be aided or controlled as necessary to hold relative humidity below 50 percent. Relative humidity should be monitored near the center of the room with a psychrometer. It is unlikely that the temperature at earlier restoration stages will have to be raised to intolerable levels to attain the relative humidity objective. At later stages, it

may be necessary to permit the relative humidity to somewhat exceed 50 percent in order to hold the temperature to a bearable level.

5.16 *Telephone switching equipment should not generally be subjected to temperatures above 130°F or damage may result to capacitors and other "potted" circuit elements*[0]

5.17 Thermometers with scales exceeding 130° F. should be provided to monitor equipment temperatures during restoration work.

5.18 Relatively inexpensive indicating psychrometers with hair elements will be satisfactory for the use covered previously. If available, a model accurate within a maximum error of 5 percent and an average error of 2-1/2 percent should be chosen.

5.19 *Desiccants have not been found useful to dry water-damaged central office or* ***PBX equipment.*** This is because relatively limited absorption capacity of these materials would make very large quantities necessary. Further, use of desiccants will generally produce a contact contamination problem.

5.20 Because of rather limited capacities with respect to the volume of water to be removed, commercial dehumidifiers have been found of only limited effectiveness during restoration work. Use of them after restoration to remove residual moisture may be considered, but is not generally recommended.

5.21 The building heating and ventilating equipment should be used, if undamaged, to help raise the temperature in equipment rooms and provide circulation.

5.22 Air may be effectively circulated through a building by using electric fans, if power is available.

5.23 Several portable sources of heat have been found to raise temperatures of damp equipment. The best sources are 250-watt infrared heat lamps equipped with swivel or clamp-on type sockets so that they may be fastened to office frames or racks made up to hold them. Another is the family of commercial heaters. A source found good for spot drying is the hand operated hair dryer. One company recently found a portable blower equipped with a heat nozzle more satisfactory than hair dryers for spot drying. The kind used was the Ideal Hand-Type Cleaner, light duty model (1/2 Hp.), equipped with an Ideal Heater Nozzle. Manhole heaters may be used but have not been found very satisfactory.

5.24 An attendant should be present at all times during the drying operation to make sure that equipment is not overheated. If necessary, electric fans may be used to assure proper distribution of warm air to prevent hot spots.

5.25 *Do not directly apply heat lamp rays to panel banks. This would soften the tar binder in the banks. Tar might flow and spread on the terminals.*

5.26 Two 60-volt arc welding sets connected in series may be used to energize heat lamps, emergency lighting facilities, etc. It may be necessary to multiple several sets to carry the load. A great deal of generating capacity will be required to energize the heating devices used in restoration work.

5.27 Approved fire extinguishers should be kept nearby during the drying operation.

Insulation Resistance Requirements and Measurements

5.28 The net normal insulation resistance on a connection through a central office or a PBX is generally about 15 megohms. ***Equipment*** *and cabling will, however, generally function satisfactorily without damage after the, drying operation has raised the insulation resistance to 3 or 4 megohms or more.* This resistance level, of course, assumes absence of relatively abnormal conditions such as silver migration, degradation of rubber insulation, etc. Insulation resistance measurements should be made throughout the office fairly frequently. They serve as a check on the drying rate.

5.29 Means of measuring insulation resistance found best for emergency use are the megger and the KS-14510 Volt-Ohm-Milliammeter or equivalent.

Operations After Drying

5.30 Corrosion products lower insulation resistance. Hence, they should be removed. If left on equipment, the corrosion products will continually

be dislodged and cause contact contamination and other trouble conditions. A stiff brush is effective to remove corrosion products if used in conjunction with a vacuum cleaner. Nylon bristle brushes of various sizes, tooth brushes, and teletypewriter cleaning brushes have been used with good results.

5.31 Equipment should be relubricated in accordance with appropriate BSPs. Relay and other contacts should be cleaned if inspection or operational tests disclose contamination. Many will need to be cleaned.

5.32 The following steps may help conserve 35- and 70-type fuses. When testing 48-volt circuits, place 150-watt 120-volt lamps instead of fuses across fuse terminals. The lamp will glow if the supplied circuit is grounded. Weatherproof "pig-tail" type lamp sockets are convenient for this test purpose. Similarly, 13-type resistance lamps may be used for preliminary testing of ringing supply circuits before the fuses are inserted.

5.33 The following may be required in panel offices:

(1) Replace cork rolls.

(2) Duplex drive motor should be reconditioned as outlined in Section 167-790-811.

(3) Inspect the friction roll and gear reduction drives to see if water has entered. If water has entered, oil in the drives should be drained and refilled in accordance with appropriate BSPs.

5.34 Some silt will remain on panel and step-by-step banks after they have been flushed and dried. It should be removed. Use a suitable stiff brush and a vacuum cleaner.

5.35 Step-by-step banks should be cleaned. All deposits between terminals must be removed or the gritty particles that they contain will cause excessive wiper and terminal wear. For procedures on cleaning, and reconditioning of step-by-step equipment, refer to the 069 Division of the BSPs.

5.36 Panel multiple brushes, guide combs, sequence switches, commutators, commutator brushes, and multiple bank terminals should be cleaned and if necessary retreated. For procedure on cleaning, treating, and reconditioning of panel equipment, refer to the 069 Division of the BSPs.

5.37 Crossbar switches and relay apparatus should be cleaned, and reconditioned in accordance with procedures in the 069 Division of the BSPs.

5.38 Alarm circuits should be treated and troubles cleared. Operational tests of associated equipment should be made before it is placed back into service.

5.39 All equipment and forms should be pressure-cleaned if needed after the office is working again. Most offices will require it. Appropriate BSPs covering pressure cleaning of the various types of equipment should be followed.

5.40 It appears desirable that maintenance engineering and plant people familiar with past performances make several "post-cutover" inspections of water-damaged central office and PBX equipment that has been restored to service. A review of office performance records before an inspection will often disclose items warranting close scrutiny. The inspections should be fairly frequent, possibly at 2-week intervals immediately after restoration, decreased in frequency later and eliminated at, say, six months. This procedure will ensure detection of any abnormal conditions that may develop. An example of this is shortened wiper life due to presence of residue silt not removed from step-by-step banks.

C. ESS Equipment

5.41 Generally, ESS equipment affected by water damage while energized will have to be replaced.

5.42 Most ESS equipment, with the battery potential removed prior to flooding, will be restorable using the established procedures of flushing, drying, testing, and inspecting. Ferrods, resistors, capacitors, relays, and filters are examples of equipment that may be restorable. Ferrods should be washed for at least 20 minutes for best results. Water may be found in the capacitors between the can and plastic cover and should be removed. Relays and relay covers should be cleaned to prevent future contact troubles. Chokes should be dried with hot air blowers or hair dryers (130° maximum temperature) to eliminate leakage to ground. Resistance readings should be taken on all relays, capacitors, and chokes affected by water damage to determine the extent of leakage to ground.

5.43 All 6A memory modules affected by flood waters should be unplugged and replaced even though serious electrolytic corrosion may not be present. The number of internal leads affected may be as high as 50 percent and the memory units would have to be completely disassembled to locate them. This would be impossible to do in the field and necessitates replacement. After the memory units affected by the flood are unplugged and removed, the connectors should once again be thoroughly washed and dried. Care should be taken during washing procedures to prevent damaging the ferrite sheets or breaking additional wires due to the force of the water.

5.44 The 1A memory modules may be restored to an electrically operative condition using the established flushing and drying operations. However, the 1A module cannot be restored to a mechanically operative condition unless all cards and springs are replaced and all grit is removed completely from the memory.

Note: For temporary restoration of service the module may be flushed and dried *without disturbing the memory cards.* This will permit restoration of service to the extent provided prior to the flood or water damage.

It is essential that the 1A card loader *not* be used to insert or to withdraw cards from a flooded memory module as irreparable damage may be done to either the memory or the loader.

Caution: Removing cards by hand may destroy the programs written on the cards.

5.45 All flooded memory modules should be replaced as soon as possible, as it is not possible to clean the modules sufficiently to permit the memory cards to be seated using the 1A card loader.

5.46 Some ESS equipment, like ferreed switches, may be replaced due to "back in service requirements", but could be reconditioned and used later. The covers of the ferreed switches should be removed and inspected before restoration begins. During the washing operation, the nozzle should be directed to spray water between the cover and the body of the switches to remove the mud trapped in the switches. The recommended drying time for ferreed switches is 3 days, but will vary due to actual conditions.

D. Circuit Packs

5.47 Circuit packs without serious corrosion may be reused after cleaning and testing. All circuit packs affected by flood waters should be removed and all contacts should be cleaned thoroughly, including those in the connector housings. Any residue left in the connector or circuit pack area will be a source for future troubles as circuit packs are removed and replaced.

5.48 The contact surfaces of all circuit packs should be cleaned with KS-7860 petroleum spirits and a KS-2423 or equivalent lint-free cloth. Only approved noncorrosive and nonfilming solvents should be used to clean the contact surfaces, as other solvents might damage the circuit pack. Abrasive substances, such as erasers, should never be used for cleaning contact surfaces. After cleaning, KS-19416 L 2 lubricant shall be applied to the contact finish. Apply solvents and lubricants to contact surface with a brush.

Caution: Do not use dip method.

Clean body of circuit pack with a dry KS-2423 or equivalent lint-free cloth. The board should be positioned with the contact paths down to allow excess lubricant to drain off. Contact surfaces should never be touched with the fingers.