

BELL SYSTEM PRACTICES
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PRESSURE TESTING

GENERAL

LAYOUT OF PRESSURE SYSTEMS

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1. GENERAL

1.01 This is a new section which describes in general terms for informational purposes the items of equipment and the major factors involved in the layout of continuous pressure systems for cables.

1.02 The engineering considerations and procedures to be followed in the actual design and layout of pressure testing systems are covered in another series of Bell System Practices. Questions regarding the engineering and layout of pressure systems should be referred to the engineer.

2. CABLE MAINTENANCE PRESSURES

Maximum Average Cable Pressures

2.01 In order to obtain maximum protection from the use of gas pressure, cable plant is maintained at as high an average pressure as practical consistent with the strength of cable sheath and sleeves. Nine pounds per square inch gauge pressure at 60°F. for buried and underground plant, and six pounds at 60°F. for aerial cable have been specified as the maximum safe operating pressures. A lower pressure has been specified for aerial cable because the protection requirements are less severe; it also prevents excessive pressure due to expanding gas during hot weather. A one-pound tolerance above this nominal operating pressure is permitted for the purpose of charging cables. Where combination aerial and underground gas sections are in use, they are maintained at six pounds if 50 per cent or more of the section is aerial and at nine pounds if less than 50 per cent of the section is aerial.

Minimum Average Cable Pressures

2.02 The minimum average pressure required to provide a satisfactory degree of protection to service in underground or buried cables depends on several factors. These include maximum waterhead likely to rise over the cable, the chance of a second or third leak occurring before a large leak is cleared, and the position of the second or third leak relative to the first. Experience has indicated that satisfactory protection is obtained if the average pressure between a sheath opening and the nearer end of a gas section in underground or buried cable is not, in general, allowed to drop below a value of two pounds.

2.03 In aerial cables, the exposure to moisture is not as severe and experience has indicated that satisfactory protection is obtained if the average pressure between a sheath opening and the nearer end of a gas section is not, in general, allowed to drop below a value of one pound. This one-pound limit prevents "breathing" and also affords a degree of protection against submersion in the event of pole line failures or floods.

Desired Average Cable Pressures

2.04 For buried and underground cable plant operated at a nominal nine-pound pressure, the average pressure is maintained between seven and ten pounds. Gas is admitted to the cable whenever the pressure drops below the lower value. When the gas section is operated at a nominal six-pound pressure, the average pressure is maintained between four and seven pounds.

2.05 This three-pound tolerance in average pressure requirements permits setting up reasonable routines in the maintenance of pressure systems. Also, when average pressures are maintained within these limits, the desired degree of protection is obtained and, in general, the average pressure will not fall below the minimum values given in Paragraphs 2.02 and 2.03 during the period after the occurrence of a leak before the leak is detected and steps can be taken to clear it or add gas to the cable.

3. LENGTH OF GAS SECTIONS

Straight Gas Sections

3.01 The length of a gas section determines the reservoir of gas in the cable and, therefore, the degree of protection provided. In general, gas sections are designed to have a length of at least 35,000 feet. Gas sections as short as 25,000 feet are accepted if the combination of aerial and underground cables in the same gas section is avoided thereby. A supplementary reservoir is usually provided for gas sections less than 25,000 feet long. In some cases, the minimum length is obtained by connecting together several short cables, such as toll entrance cables in a central office vault.

3.02 There is no maximum limit on gas section length and, in general, gas sections are made as long as practicable, consistent with maintenance boundaries and convenience of operation. Very long gas sections, 20 miles or greater in length, are advantageous on cables with a low leak expectancy. On cables with a high leak expectancy, particularly the older aerial toll cables, the maximum desirable length of gas section is from 50,000 to 60,000 feet. Sections are limited to this length to reduce maintenance effort associated with maintaining adequate operating pressures and recharging operations when the gas loss is high.

Circular Gas Sections

3.03 On routes where there are two paralleling cables, the cables are frequently connected together at the ends to form a circular section. This provides a gas section which is continuous and eliminates the low pressure critical zones which exist adjacent to the ends in straight sections. Equal protection is thereby obtained throughout the section. If there are three cables on a route they are frequently interconnected and operated in parallel. If there are four cables on a route, they are generally operated in pairs. The length of circular sections is determined in the same manner as for straight gas sections.

4. PRESSURE TESTING EQUIPMENT

Pressure Plugs

4.01 Pressure plugs are located so as to divide the cable into gas sections, to seal off branch cables not included in the gas system, and terminals which are not gastight.

4.02 In addition, plugs shunted by a by-pass connection equipped with a shut-off valve are installed at the following locations. These valves are normally kept open and are closed only when subdivision of the section is desired.

(a) At terminal poles in combination sections so that aerial cable can be isolated from the underground portions. This eliminates the effects of differences in temperature in leak location work.

(b) At both ends of a submarine cable, to permit isolation so that the pressure in the submarine cable may be quickly raised in the event of an underwater leak.

Contactors and Contactor-Terminals

4.03 In continuous pressure systems equipped with alarm, contactor-terminals are installed in the manhole at contactor points on underground cable and at the pole on aerial cable. Contactors and separate gastight terminals are installed on buried cable; the contactors are buried below ground to operate at cable temperature and the terminals are mounted above ground on markers to provide access to the talking facilities. The contactors are adjusted to operate when the pressure falls to six pounds on a nine-pound system, and to three pounds on a six-pound system.

4.04 The limits for contactor spacing for various type gas sections are as follows:

(a) **Nine-pound underground section:** About 10,000 feet apart with first contactor about 5,000 feet from plug.

(b) **Six-pound aerial section:** About 16,000 feet apart with first contactor about 8,000 feet from plug.

(c) **Nine-pound combination aerial—underground section:** Aerial portions same as (b) above. Underground portions same as (a) above.

(d) **Six-pound combination aerial—underground section:** Aerial portions same as (b) above. Underground portions about 7,000 feet apart with first contactor about 3,000 feet from plug.

4.05 Considerable latitude exists in the above limits and spacings are varied where improvements can be made in accessibility or working conditions at the location. Also,

contactors are located so as to favor quick operation in the event of sheath openings at critical points such as stream crossings or underground dips on aerial cables.

Permanent Valves

4.06 Permanently installed pressure testing valves are used for charging cables with gas, making routine readings to determine average pressure and rate of gas loss, making measurements for leak locating purposes, and checking the operation of plugs and contactors. In general, valves are permanently installed at the following locations:

- (a) At each contactor and contactor-terminal location.
- (b) On each side of all intermediate plugs and on the pressure side of plugs at the end of gas sections.
- (c) At uniform intervals of about 3,000 feet throughout the gas section. Spacings of less than 3,000 feet are used in some cases in order to improve accessibility or regularity of spacing.
- (d) At other locations when required to provide accessible points at road crossings for charging cables or making routine readings.