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BELL SYSTEM PRACTICES
Outside Plant Construction
and Maintenance

SECTION G73.415.4
Issue 1, December, 1952
AT&T Co Standard

PRESSURE TESTING
LOCATION OF GAS LEAKS
ANALYSIS OF PRESSURE GRADIENTS

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1. GENERAL

1.01 This section replaces the information previously contained in Section G73.245, Issue 1, covering the analysis of pressure gradients for cables under gas pressure. A general discussion is given of the characteristics of pressure gradient graphs, and of the way of determining which of the gradient lines to project to obtain an indicated leak location.

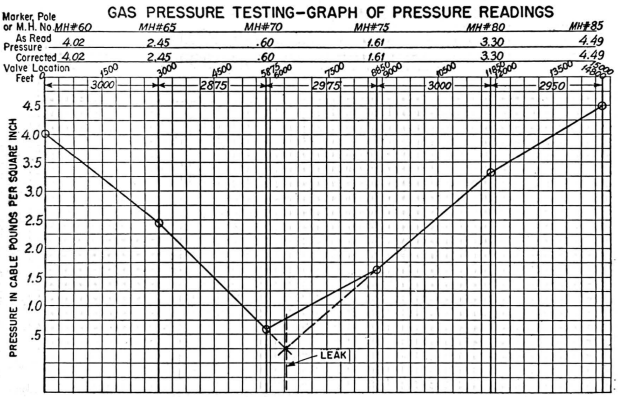
1.02 The analysis of pressure gradient graphs requires the exercise of skill and good judgment. The workman must have a thorough knowledge of the cable plant, the conditions under which the tests were made, and the past maintenance history of the section of cable under test. Consideration must also be given to the approximate position of the leak relative to the ends of the gas section and the general shape of the pressure gradient for considerable distances on each side of the leak.

1.03 The procedure for analysing a graph is the same for both large and small leaks. The first step is to scrutinize the general shape and determine if it is the type of graph that would be expected. The slope of the connecting lines between valve points should be checked to see that the slope becomes steeper as the location of the leak is approached. If the graph is irregular and does not meet these requirements it is an indication that it may not be dependable and that a new set of readings may be required. Such possibilities as restrictions in the cable and additional leaks in the vicinity should be considered in the inspection of such graphs.

1.04 The examples of pressure gradient graphs given in this section are intended merely as guides to analysis. In some cases, locations will not be so clearly indicated as those of the leaks used for illustration. This is particularly true in the case of a very small leak, where slight inaccuracies in measuring pressures or slight differences in temperature along the gas section may cause irregularities in the plotted pressure gradient. In general, small irregularities, such as .01 pound, should be neglected unless they are found to occur at the same points for several sets of pressure measurements.

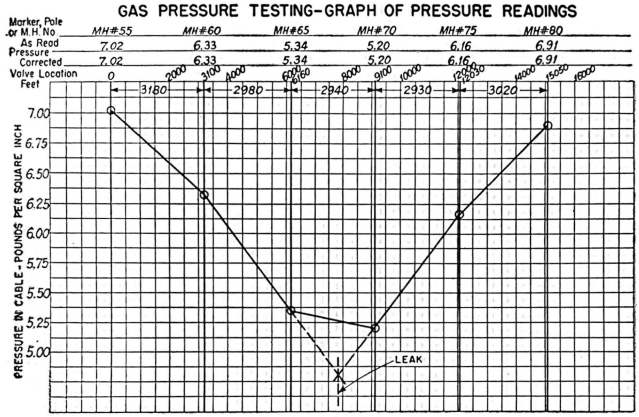
2. LEAK IN CENTER OF GAS SECTION

2.01 The following figure shows the pressure gradient graph for a large leak in the center portion of a gas section. The portions of the gradient on the two sides of the low point have the same general height. On the left-hand side of the low point, the gradient line connecting the plotted points at manholes 65 and 70 is steeper in slope than that connecting the points at manholes 60 and 65. On the right-hand side of the low point, the line connecting the points at manholes 70 and 75 has less rather than greater slope than that connecting the points between manholes 75 and 80. The leak is, therefore, between manholes 70 and 75, and projections should be made as shown by the dashed lines. The indicated location of the leak is at the point of intersection of these dashed lines.



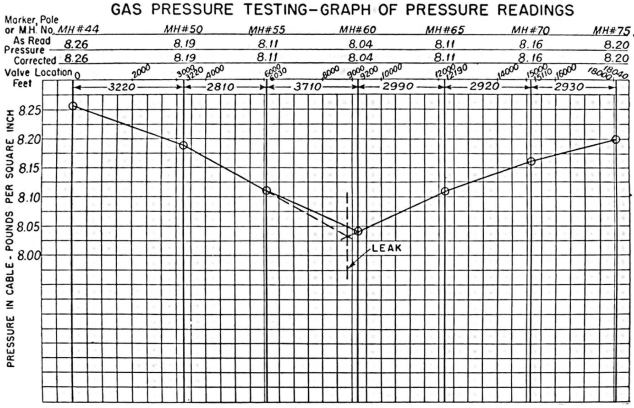
LOCATION OF LARGE LEAK
CENTER PORTION OF GAS SECTION

2.02 The pressure gradient graphs for a medium and a small leak in the center portion of a gas section are shown in the following figures. As in the case of the large leak, the location is on the side of the low point where the gradient line to the next adjacent point has a lesser slope than the gradient line immediately above it.



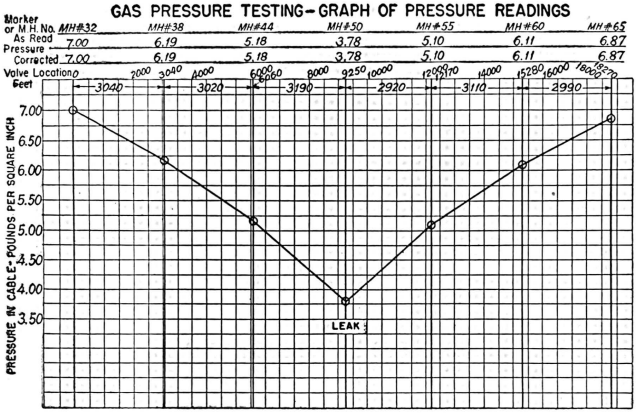
LOCATION OF MEDIUM LEAK
CENTER PORTION OF GAS SECTION

GAS PRESSURE TESTING–GRAPH OF PRESSURE READINGS



LOCATION OF SMALL LEAK
CENTER PORTION OF GAS SECTION

2.03 In the case of a leak which is at or very close to a valve point, the gradient lines connecting the low point to the adjacent point on each side are both steeper in slope than the gradient lines immediately above them, and projections to a point of intersection can not be made. This is illustrated by the following figure for a medium leak in the center portion of a gas section.

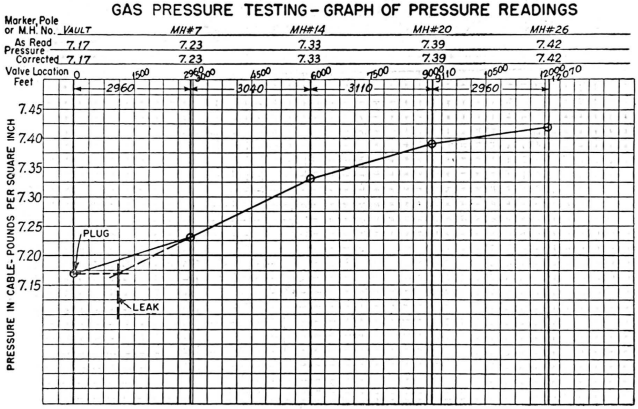


LOCATION OF MEDIUM LEAK AT VALVE POINT
CENTER PORTION OF GAS SECTION

3. LEAK NEAR END OF GAS SECTION

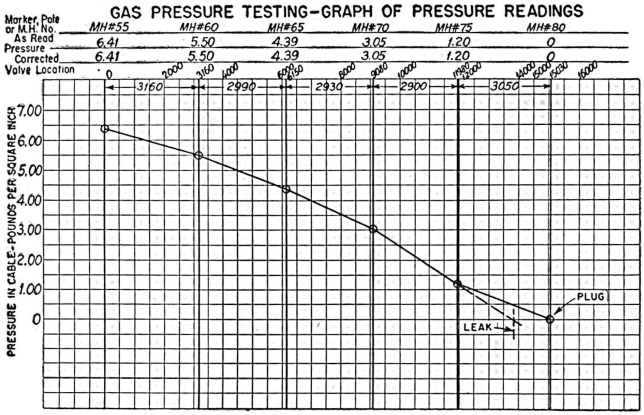
3.01 For a leak away from the center portion of a gas section, the general height of the pressure gradient on one side of the low point may be appreciably less than that on the other. The lines that are to be projected can be found, however, by observing on which side of the low point an irregularity in slope occurs.

3.02 In the case of a leak that is very close to an end of a gas section, the pressure at the plug is practically the same as that at the leak, and the gradient has the general shape shown in the following figure. The slope of the line joining the plotted pressures of the plug and the adjacent valve point is less steep than that of the gradient line above it. To locate the leak, a horizontal line is drawn through the plotted plug pressure and projected to its point of intersection with a line drawn through the point at which the change to lesser slope occurs, as illustrated below.



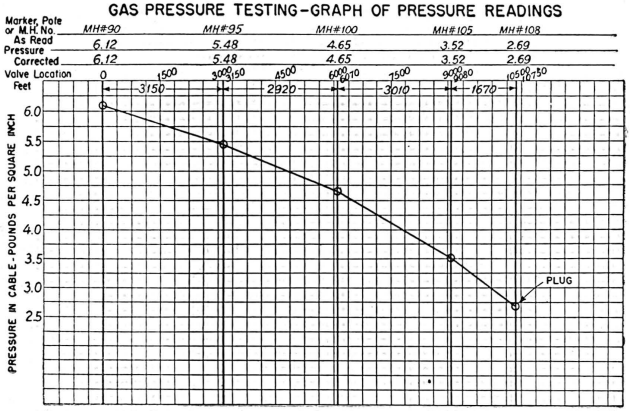
LOCATION OF SMALL LEAK NEAR END OF GAS SECTION

3.03 In the case of a leak that is very close to an end of a gas section and the pressure at the plug is zero, the gradient should be projected to the zero pressure line of the graph as illustrated in the following figure.



LOCATION OF LARGE LEAK NEAR END OF GAS SECTION

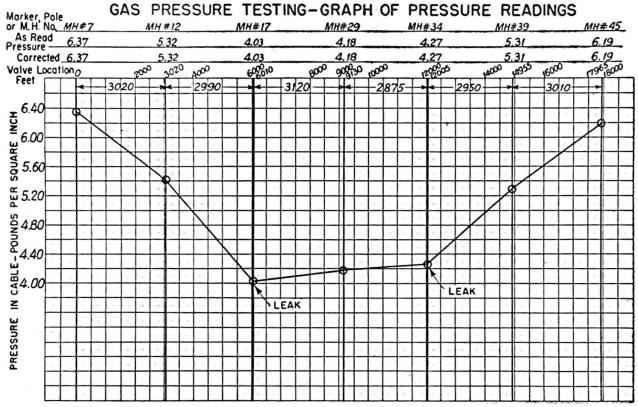
3.04 The gradient graph for a leak which is at an end plug of a gas section is shown in the following figure. In this case the line connecting the plotted pressures of the plug and the adjacent valve is steeper than that of the gradient line above it, and projections to a point of intersection can not be made.



LOCATION OF MEDIUM LEAK AT END OF GAS SECTION

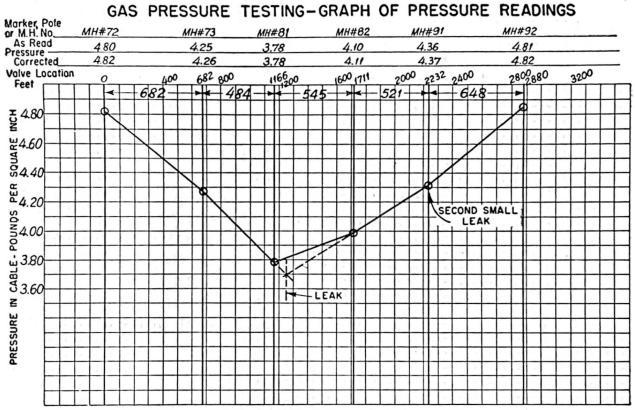
4. MORE THAN ONE LEAK

4.01 Following is an illustration of a pressure graph with two medium leaks. The shape of the gradient indicates the existence of one leak between manhole 17 and manhole 29 and a second leak between manhole 29 and manhole 34. No leak intersection was obtained because of the influence of the second leak on the gradient. Where two leaks are relatively close together the larger one should be located and cleared first. This will require the installation of additional valves in the critical section between manhole 17 and manhole 29 in order that the shape of the gradient adjacent to the leak can be definitely determined. After the first leak has been cleared the location of the second leak can be determined by another set of pressure measurements.



LOCATION OF MEDIUM LEAK
EFFECT OF TWO LEAKS ON GRADIENT

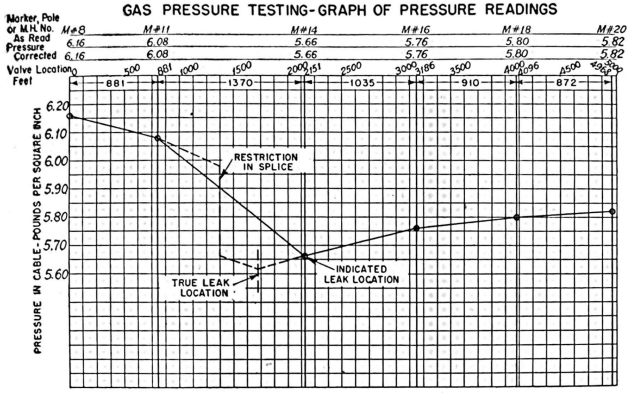
4.02 The following figure shows the effect of a second small leak on the pressure gradient for the location of a medium leak. In this case a leak intersection was obtained; however, the location is not dependable because of the unknown location of the second leak and its possible influence on the slope of the gradient in the critical position between manhole 82 and manhole 91.



LOCATION OF MEDIUM LEAK
EFFECT OF SECOND SMALL LEAK ON GRADIENT

5. EFFECT OF RESTRICTION

5.01 The partial stoppage that sometimes occurs at a paraffin filled splice offers resistance to the flow of gas through the splice and there may be a considerable difference between the pressures on the two sides of the restriction. Following is an illustration of a pressure gradient graph for a small leak which is distorted by such a condition.



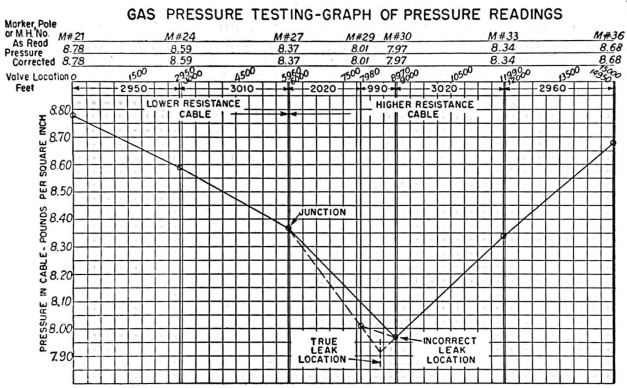
LOCATION OF SMALL LEAK
EFFECT OF RESTRICTION

5.02 The solid lines represent the pressure gradient as constructed from pressure measurements. The error in the leak location is due to a distortion in the graph because of a paraffin restriction in a splice between manhole 11 and manhole 14. This obstructed the flow of gas and held the pressure on the left side of the graph to a high value. Additional measurements indicated that there was a difference in pressure of about .30 pound on the two sides of the restriction. The true pressure gradient had the shape of the short dashed lines shown on the graph.

6. EFFECT OF JUNCTION OF DIFFERENT TYPES OF CABLE

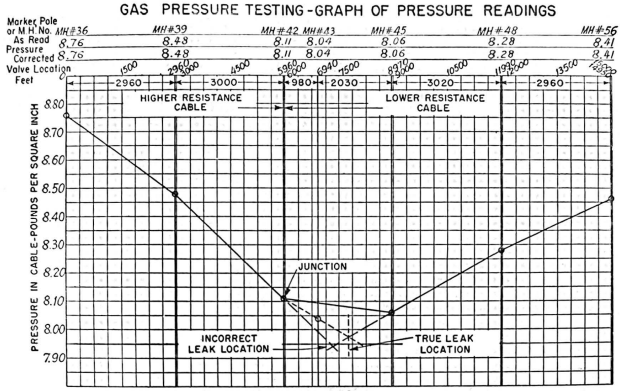
6.01 When the leak is near a junction between cables of appreciably different pneumatic resistance, irregularities will be introduced into the shape of the gradient. The pressure at the junction and the relative slope of the gradient lines on each side of the junction will adjust themselves in accordance with the relative resistances of the adjoining cables. The rate of gas flow along the cable will be the same on each side of the junction but the cable having the higher resistance will have a steeper gradient than the cable having the lower resistance.

6.02 The following figure shows the effect of a junction of two cables having different resistances on the location of a small leak when the leak is in the cable having the higher resistance. The solid lines represent the pressure gradient obtained when the effect of the difference in resistance of the cables is neglected. In this case, the gradient indicates the leak to be at manhole 30. However, when an additional pressure measurement is made at manhole 29 the true slope of the gradient between the junction and the leak is determined and a leak intersection is obtained as indicated by the dashed lines on the graph.



LOCATION OF SMALL LEAK
EFFECT OF JUNCTION OF DIFFERENT TYPES OF CABLE
LEAK IN HIGHER RESISTANCE CABLE

6.03 When the leak is located in the cable having the lower resistance the pressure gradient will have an appearance as illustrated in the following figure. The solid lines represent the pressure gradient obtained when the effect of the junction is neglected and, as a result, an incorrect leak intersection is obtained. The short dashed lines represent the true leak intersection obtained when an additional pressure measurement is made between the junction and the leak and the true slope of the gradient is determined in this critical portion.



LOCATION OF SMALL LEAK
EFFECT OF JUNCTION OF DIFFERENT TYPES OF CABLE
LEAK IN LOWER RESISTANCE CABLE

7. EFFECT OF JUNCTION OF BRANCH CABLE

7.01 When a leak occurs in a cable near a junction with a branch cable, there will be an irregularity in the shape of the pressure gradient similar to that illustrated by the graph in Paragraph 6.02. The branch cable acts as an additional reservoir of gas supplying the leak; the flow in the main cable beyond the junction will thus be less than in the portion between the junction and the leak. This results in a change in slope of the gradient at the junction. The degree of the irregularity introduced depends on the size of the additional reservoir of gas connected at the junction. Similar effects may be encountered in the pressure gradient of a small leak due to gas filled load coil or filter cases.