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PRESSURIZATION OF THE LOCAL OSCILLATOR LINES

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It is proposed to fill the local oscillator lines with dry nitrogen at about 15 pounds/sq.in. to keep out moisture and ensure operation at a constant electrical length. The increase in pressure will change the electrical length in two ways: the dielectric constant is raised, and the diameter of the waveguide is increased. Both effects increase the phase length of the line.

The dielectric constant n is given by:

$$n = 1 + \frac{79P}{T} \times 10^{-6}$$

where

P = pressure in millibars

T = temperature in ^{o}K. (Pawsey & Bracewell, p. 342)

This assumes that the water vapor content is zero. Adopting ΔP = 1000 mb (1 atmosphere) and T = 290 ^{o}K,

$$\Delta n = \frac{79 \times 10^{3}}{290} \times 10^{-6} = 272 \times 10^{-6}$$

Or, since $\lambda_g = \lambda_{go}/n$, the fractional change in electrical length is 272 pants per million! The longest oscillator line is about 400 feet or 4400λ. Over this length the phase change is

$$\Delta\Phi = 360 \times 4400 \times 272 \times 10^{-6} = 430^{o} \text{ per atmosphere}$$
$$= 29^{o} \text{ per pound of pressure}$$

The increase of waveguide diameter with pressure is discussed in Glint No. 189. For a 3/4 inch radius pipe with 1/16 inch walls, a ΔP of one atmosphere produces a $\Delta R/R$ of 16.9×10^{-6}. Then

$$\frac{\Delta\lambda_g}{\lambda_g} = -\left(\frac{\lambda_g}{\lambda_c}\right)^2 \frac{\Delta R}{R} = -\left(\frac{3.1}{6.5}\right)^2 \times 16.9 \times 10^{-6} = -3.9 \times 10^{-6}$$

per atmosphere

This effect produces a phase change of only 6° per atmosphere in the longest line and is negligible.

The results suggest that all five lines should be under a common pressure, and that the pressure must be watched carefully. Assuming the largest differential in line lengths to the antennas is 200 feet, a change in pressure of 1 lb/sq. in. will produce a phase change of 15°. Experimental results reported in Glint No. 159 verify this conclusion.