FURTHER NOTES ON MICROWAVE LINKS

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This memorandum summarizes some further information on the microwave link for the Southern New Mexico antenna obtained since VLBA memorandum No. 240 was written.

Fading Margin

In VLBA Memo. No. 240 a total fading margin of 40 dB was used, to allow for multipath effects (30 dB) and rain (10 dB). I have since talked to J. Schiavone of Bell Labs who is a meteorologist, and in his opinion it is not necessary to sum the two affects since rain would be likely to break up the atmospheric layering that causes multipath propagation. The most useful data that I have been able to find on multipath fading are in Vigants (1975), Hall (1979) and CCIR Report 338-3. From these sources it seems that for a 75 km path at 18 GHz the probability of a fade level lower than -20 dB is about 10^{-2} and lower than -30 dB about 10^{-3}. These probabilities indicate the fraction of total time that the signal would be below the indicated level for the worst month of the year. Durations of individual fades of the magnitude considered above are typically 4-10 sec. For VLB purposes an overall fade probability of -30 dB, which would result in a loss of 8.8 hours per year, would probably be tolerable. However I have no information on how much more fading is to be expected during the worst month than would occur on average. As a best guess at the required fading margin I shall now use 25 dB.

With the above figure, the fading margin used in estimating the required transmitter power for a link from Winston to the VLA site in VLBA Memo No. 240 was 15 dB too high. Thus the power can be reduced from 250 W to 8 W. It was also stated that a further 10 dB could be obtained by using a cooled FET receiver at the VLA end of the link. This was too optimistic: for an antenna pointed horizontally or receiver temperature of 150K seems reasonable, giving only a 3 dB increase in sensitivity. This should probably be allocated to feeder losses, which were omitted from the earlier estimate.

Possible Sites

Better information on possible sites is now available as a result of an excursion on June 21 by P.J. Napier and A.R. Thompson. In the Rio Grande valley two possible locations were identified, one being the general vicinity of the Truth or Consequences Airport, 12 km north of the town and 1.5 km west of Interstate 25. The other site is on State road 52 approximately 8 km west of the airport and 3 km west of Cuchillo. A power line crosses the road at that point and South Baldy is just visible through a low point in the San Mateo foothills. South

Baldy would provide a repeater site for both locations, the distances being as follows:

T or C Airport or Cuchillo to S. Baldy	84 km	angle 89° to 94°
S. Baldy to VLA site	40 km	

The best site in the Winston vicinity appears to be 13 km north-west of the town on state road 59, 4 km west of the junction with road 52. This is on Forest Service land at a point where a power line crosses the road, and a telephone line is also present. From this location Oak Peak, Mt. Withington and South Baldy are all visible, the last rising just above the San Mateo Range. Mt. Withington would be a much better site for a passive reflector than Oak Peak because there is an access road to a lookout tower at the peak, and also a clearer line of sight from the VLA site. The line of sight to Oak Peak from the VLA site grazes the rising ground to the south of the VLA for several miles. There is no electric power at Mt. Withington, so South Baldy would have to be used if an active repeater is necessary. The distances involved are as follows:

North Winston to Mt. Withington	49 km	angle 126°
Mt. Withington to VLA Site	24.6 km	
North Winston to S. Baldy	74 km	angle 63°
S. Baldy to VLA Site	40 km	

Distances for the paths via Mt. Withington are almost equal to those via Oak Peak, so the transmitted signal level should be about 8 W for the IF signals as discussed earlier. If a passive reflector were used on S. Baldy the increased distances would require a further 8 dB.

An inspection of the peak area of Mt. Withington by P.J.N. and A.R.T. on July 1 indicated an area within 100 m west of the lookout tower is a possible site for a reflector. The VLA is easily visible and the line of sight in the general direction of the north Winston site is clear, at least in the vicinity of the San Mateo Range. The distance of the north Winston site was too great to identify any details.

Conclusion

We have identified the best location areas for the southern N.M. antenna and possible repeater sites. Present calculations show the simplest solution, that is the north Winston site with passive repeater on Mt. Withington, to be marginal. Also for this site the line of sight to South Baldy is not so good as from the Truth or Consequences area. The possibility of getting a local person to

change tapes if the link is out of action is also much better for the T or C area. However the electromagnetic environment is likely to be better in the Winston area. To help clarify the situation I suggest that we obtain the services of a consultant in microwave link design to examine the possibilities in detail and give us a better estimate of likely performance.

I talked to Dr. Vigants and he told me that as an employee of Bell Labs he would not be able to perform outside consulting, but recommended Mr. K. Bullington, former head of the propagation group at Bell Labs, now a private consultant. I called Mr. Bullington and found that he would be interested in helping us with evaluation of the propagation problem. He pointed out that fading characteristics would vary considerably over a 200 MHz bandwidth and that it might be advisable to use a separate subcarrier for each IF channel. Brief biographies of both Mr. Bullington and Dr. Vigants can be found in the Bell System Technical Journal, Vol 54, pages 203 and 206, 1957. Addresses and telephone numbers are as follows:

Dr. A. Vigants, Bell Labs, (201) 870-7450

Mr. K. Bullington,
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Colts Neck, New Jersey 07722
(201) 946-9785

References

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Hall, M.P.M., Effects of the Troposphere on Radio Communication, Peter Peregrinus, Stevenage, U.K., 1979.

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