ARRAY EXPANSION.

by

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In designing the DUMAND2 array, we should bear in mind the possibility that at some future time it might become desirable to increase the power consumption of the array. This could come about because of a desire to expand the array, either as a result of its success in detecting neutrinos, or because there was reason to believe that an additional sensitivity would turn the trick. Or it might be because of technological reasons: e.g. an additional piece of equipment using more power than originally programmed might become necessary or desirable.

In either case, it is worth looking at the array design to see what the possibililties are for such expansion, and to choose a design, if possible without undue sacrifice, that allows such expansion. As far as the power consumption is concerned, the critical items here are the source voltage, which is limited by the dielectric thickness of the cable; and the cable resistance, which limits the maximum power that the cable can deliver to a 350-volt load.

The present cable design envisions a 1-mm dielectric thickness, allowing a source voltage of 1970 volts. Fig. 1 shows the maximum power that can be delivered to a 350v supply through the cable for various values of cable resistance; it also shows the corresponding power at the source. The nominal 60-ohm cable can deliver at most just over 9 kw; the 40-ohm cable 14, and the large and expensive 20-ohm cable 28.3kw.

Since the nominal power consumption per string, including the regulator current, is 6.05/9 = .67kw, the 60-ohm cable can supply 13 strings. At the same power consumption per string, the 40-ohm cable can supply 21 strings, and the 20-ohm cable 42. In this calculation we have increased the regulator current proportionally to the total current.

Are there other constraints that prevent an increase of array size? We must consider the following:

1. Fiber output data. We are not increasing the number of fibers; so the present fiber supply must suffice for the expanded array. This is probably the most critical item. The fiber traffic capacity is certainly adequate; the problem will be how to multiplex additional data on the existing fibers. It

seems plausible that by the time we face this problem (certainly not before 1996) a solution to this multiplexing problem will have been found.

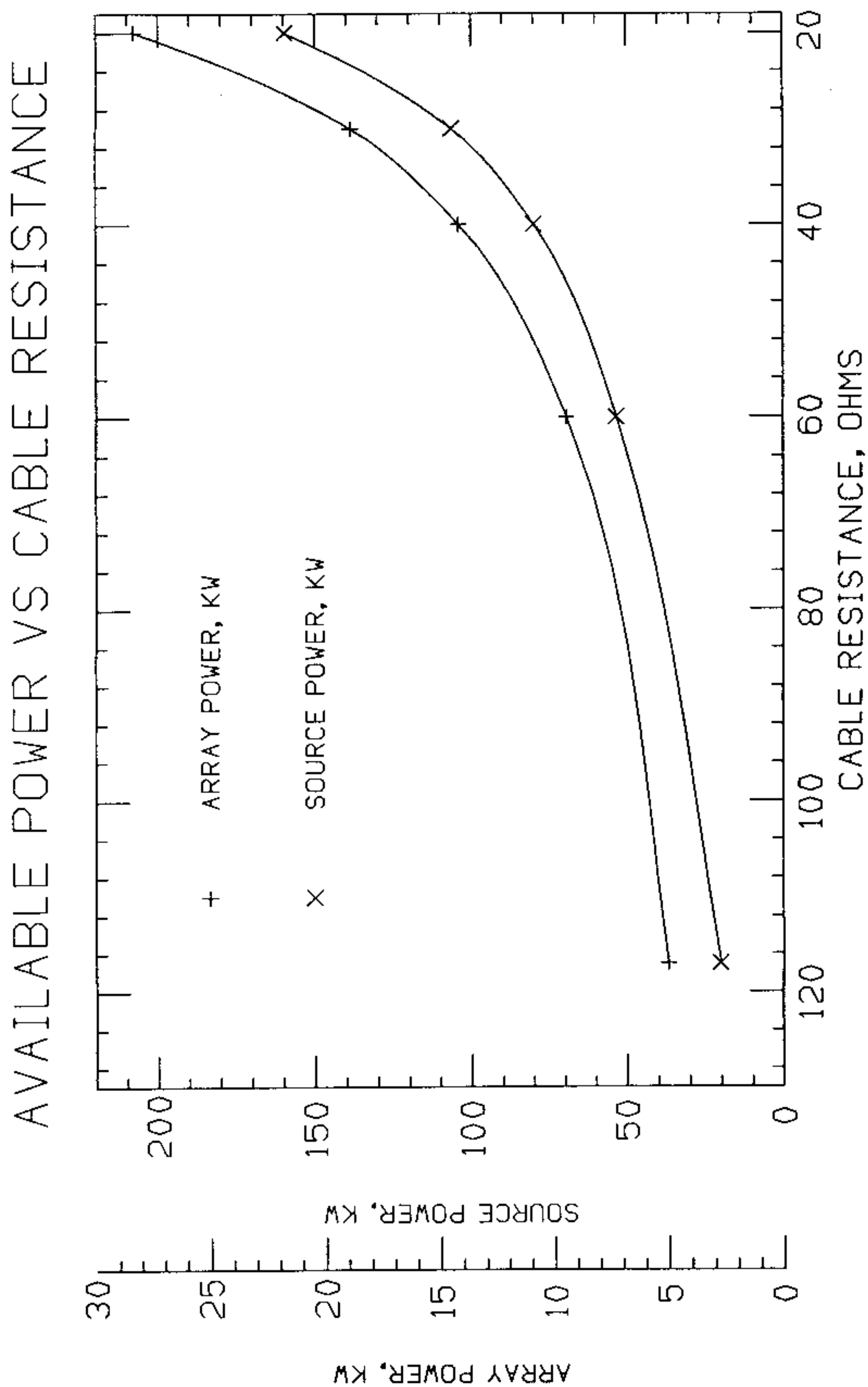
2. Equally important is the capability of the shore decoder station to cope with the increased data stream. Again we rely on plausibility arguments.

3. The increased current capacity of the junction box regulator can be achieved without entering the box. The regulator consists of a system of parallel chains, each carrying a fixed current. The number of such chains increases with the current load, but there seems to be no reason why they cannot be in a small auxiliary external junction box addition, using a branch on any parallel output cable. There will have to be Y branches on the power cables and the optical cables to accomodate the additional strings.

4. An alternative expansion procedure is to increase the height of the strings, in addition to or instead of their number. This requires removal of the old strings as well as deployment of the new ones. It makes less demands on fiber optics signal division. This would call for string power supplies of higher capacity than the present 300w. units; they would be installed in the new strings.

The least expensive shore cable for the present array is probably the 60-ohm one; this allows only a modest expansion to 13 strings, which is not enough to be worth the trouble. The 40-ohm cable allows 21 strings, about the smallest expansion one would consider. From here on to 20 ohms, we must balance cost against possible advantage.

Of course, a major expansion to DUMAND3 – meaning at least a tenfold increase of size – cannot be achieved by such simple means as this. That sort of expansion means a new cable and a system redesign.


AVAILABLE POWER VS CABLE RESISTANCE
+ ARRAY POWER, KW
× SOURCE POWER, KW
CABLE RESISTANCE, OHMS
20
40
60
80
100
120
SOURCE POWER, KW
0
50
100
150
200
ARRAY POWER, KW
0
5
10
15
20
25
30