DYNAFOAM COAX COMES OF AGE FOR CATV

written and presented by:

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INTRODUCTION:

Two years ago, Times Wire and Cable introduced a new low loss, high efficiency, semiflexible coaxial sheath cable designed primarily for use in Cable Television Systems. Since that time over three thousand miles of cable has been manufactured, delivered on site and installed. This paper is to further inform the industry about this, to our mind, important developement.

WHY SEARCH FOR LOWER LOSS CABLE?

CATV Cables are designed primarily to transport signals from one point to the other as efficiently as practical. In the typical Cable Television System, how well this is accomplished, all other things being equal, can be judged by a comparison of cable loss versus dollar cost.

What we are saying is that an increase in the efficiency of the cable is of no value if its cost increases at a rate equal to or greater than the rate of increase of efficiency. A convenient way to make this judgement is to multiply the cost of the cable by the attenuation. If a substitute cable, analyzed the same way, shows a smaller number it is possible to achieve a more cost effective system by its use.

A further stimulus to the developement of lower loss cable has been the desire to go to longer trunk runs. It is presumed that in these cases the economics are governed by front end location and construction costs rather than the less complicated analysis cited above.

This is best illustrated by assuming a trunk run designed on 22 db spacing and 36 amplifiers in cascade. The possible length of run is tabulated below.

JT-1750 (Polyethylene)	15 miles
JT-2750 (Dynafoam)	20 miles
JT-21000 (Dynafoam)	25 miles

The maximum length of run can of course vary with design criteria, but the comparison is still valid.

In summary, lower loss cables are developed to achieve overall reduction in system construction and maintenance cost.

DESIGN CONSIDERATIONS:

Dynafoam cable was developed with the intention to offer the system designer lower loss for the installation dollar and to increase the length of usable trunk run where, for one reason or another, it might be required; without having to resort to air dielectric cables, where pressurization costs can eat up any original economies attained.

Examination of the general formula for cable loss

$$\alpha = \frac{0.0174}{\text{Ln } D/d}\left(\frac{0.414}{d} + \frac{0.525}{D}\right)\sqrt{Ke}\quad\sqrt{F} + 2.78 \text{ Tan } \delta \sqrt{Ke}\quad F$$

indicates that greater efficiency can be achieved by reduction of Dielectric Constant.

Furthermore when one considers that

$$Zo = \frac{60}{\sqrt{Ke}} \text{ Ln } D/d$$

it becomes apparent that the diameter of the inner conductor (d) must be made larger to maintain the proper impedance. This of course leads to a further reduction in cable attenuation.

Dynafoam cable accomplishes this by taking advantage of the greater foamability of Polystyrene over Polyethylene. Where Foamed Polyethylene limits the Dielectric Constant to values of 1.55 or greater, it is possible to achieve values of as low as 1.20 by using foamed Polystyrene.

For purposes of comparison the following table compares the overall diameters of cable having substantially the same attenuation against the insulation used.

Dynafoam	Foamed Polyethylene
0.340	0.412
0.412	0.500
0.500	0.750

Figure one shows the attenuation values of all Dynafoam cables versus Frequency from 10 MHz to 1000 MHz.

Simplified formulae are tabulated below for calculating the attenuation of all Dynafoam Cables.

$$\text{JT-2340}\ \alpha = 0.1010\sqrt{F} + 0.00074\ F$$
$$\text{JT-2412}\ \alpha = 0.0827\sqrt{F} + 0.00060\ F$$
$$\text{JT-2500}\ \alpha = 0.0671\sqrt{F} + 0.00051\ F$$
$$\text{JT-2750}\ \alpha = 0.0444\sqrt{F} + 0.00040\ F$$
$$\text{JT-21000}\ \alpha = 0.0336\sqrt{F} + 0.00040\ F$$

When it is considered that the major cost of cable is material and that the amount of material in a cable is a function of at least the square of the diameter it becomes obvious that a smaller cable having the same attenuation as one that is larger will lead to greater economy.

MECHANICAL CONSIDERATIONS:

When first designed, the Dynafoam line was set up using the same mechanical criteria as the older Alumifoam Cables except that the inner conductors were adjusted to achieve the 75 ohm Characteristic Impedance required.

Subsequently it was found that the cables, particularly JT-2500 and JT-2750 were subject to mechanical change upon installation.

It was found that the 1/2" and the 3/4" cables had a tendency to flatten when bent on small radii.

The problem existed because the polystyrene air mixture used for insulation gives far less physical support than polyethylene foam. A bending jig was designed, Figure two, which maintains the circularity of the cable during bending.

Additionally it was found that JT-2500 and JT-2750 had some tendency to kink as it came off the reel. This problem, related to the same reduced support by the insulation, was effectively solved by increasing the wall thickness of the aluminum sheath. In both cases it was found that the problem was solved by a relatively minor increase in Aluminum Sheath wall thickness of only 0.005".

The following table shows the mechanical dimensions of Dynafoam Cable.

Cable Type	Inner Conductor O.C.	Insulation O.D.	Outer Cond. Wall	O.D.
JT-2340	0.075	0.300	0.020	0.340
JT-2412	0.092	0.362	0.025	0.412
JT-2500	0.114	0.440	0.030	0.500
JT-2750	0.172	0.666	0.042	0.750
JT-21000	0.227	0.890	0.055	1.000

INSTALLATION EXPERIENCE:

At the present time installations of Dynafoam Cable have been made in approximately thirty states ranging from Idaho to Florida. The cable has been supplied with and without jacket for aerial installation, and both flooded, jacketed and armored for underground installations.

As a matter of course, because the cable design represented a departure from what installation crews have been used to, several installations were checked out thoroughly, including return and insertion loss measurements both prior to and after installation.

It can be reported that, if installed with a reasonable degree of care and if the installer refrains from pulling around sharp corners, uniform cable prior to installation will be uniform after it is installed. The same can be said of foam Polyethylene cables.

What constitutes a careful method of installation is governed by the particular characteristics of the job at hand. Each man on the job can probably think of ways to install the cable without damage and we can not offer hard and fast rules for such a varied problem. We can offer some general rules that will help. I might add that these suggestions apply to the more conventional Aluminum Cables as well as to Dynafoam.

1. Some method of reel braking should be available.
2. Care should be taken to lead cable into the installation without excessive wall pressure.
3. Cable should not be pulled around right angle bends.
4. Cable pulling tensions should not be exceeded.

Some studies have been made to determine aging characteristics for Dynafoam cable. These studies, made on actual installations consisted of return and insertion loss measurements performed on installed cable after two years of service life. In no case was any deterioration in either transmission efficiency or cable uniformity noted.

Our studies have disclosed no indication of the various postulated possible faults which might develope.

1. We have found no indication of cracking dielectric. The material used in Dynafoam is sufficiently flexible for the task.
2. We have found no evidence of inner conductor wandering.
3. Insertion loss measurements after 2 years installation indicate no moisture absorption by the cable.
4. We have found the cable to react predictably to temperature changes.

ECONOMIC FACTORS:

In order to estimate the economic advantages of Dynafoam cable an analysis was performed using the following assumptions.

1. 100 mile system.
2. 70 miles of JT-1412 or JT-2340.
3. 15 miles of JT-1500 or JT-2412.
4. 15 miles of JT-1750 or JT-2500.
5. Substitution of the more efficient cable would not lead to a significant reduction in the number of amplifiers used in the system nor require any excessive variation in cost of installation.
6. Cost savings are based on Times Wire and Cable published price date for 100 mile quantities.

	Alumifoam	Dynafoam
Cost of 70 miles of JT-1412	$26,900.00	
Distribution JT-2340		$22,900.00
Cost of 15 miles of JT-1500	7,520.00	
Sub Trunk JT-2412		6,500.00
Cost of 15 miles of JT-1750	16,650.00	
Trunk JT-2500		9,350.00
Total Costs	$51.070.00	$38,750.00
Savings	$12,220.00	

FOR JACKETED SYSTEM:

70 miles JT-1412-J	$31,200.00	
JT-2340-J		$27,800.00
15 miles JT-1500-J	9,130.00	
JT-2412-J		7,690.00
15 miles JT-1750-J	18,700.00	
JT-2500-J		10,950.00
Total Costs	$59,030.00	$46,440.00
Savings	$12,590.00	

CONCLUSION:

It can be concluded that after over 2-1/2 years of installation experience and after more than three years prior experience in the factory and laboratory, Dynafoam cable represents a progressive step forward in the developement of better, more efficient cable system designs.

It offers the user basic economies for the construction of normal plant and in certain instances, where long trunk runs are required, a method of getting the best signal possible to remote areas.

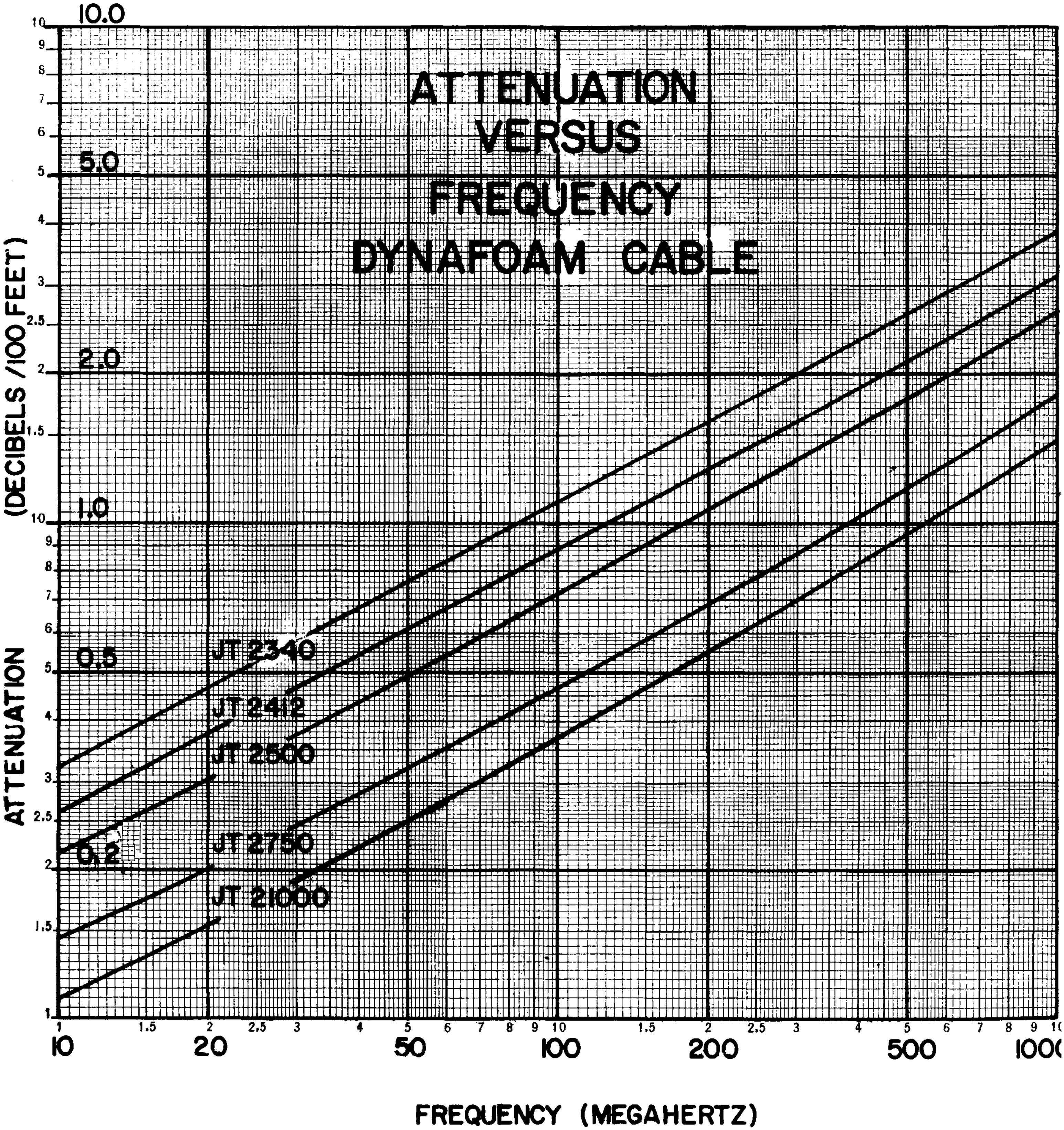
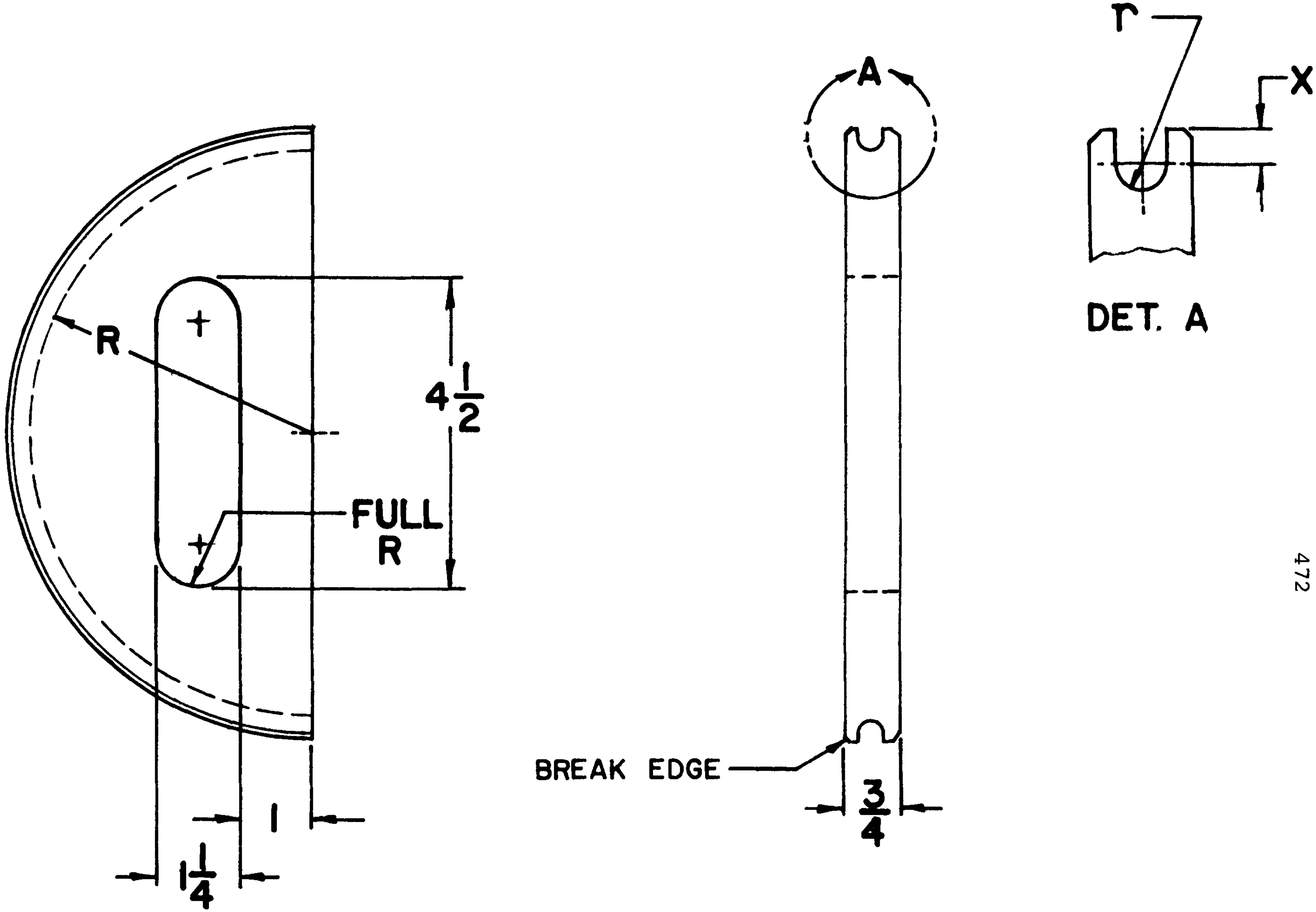

ATTENUATION VERSUS FREQUENCY DYNAFOAM CABLE
ATTENUATION (DECIBELS /100 FEET)
10.0
5.0
2.0
1.0
0.5
0.2
JT 2340
JT 2412
JT 2500
JT 2750
JT 21000
10
20
50
100
200
500
1000
FREQUENCY (MEGAHERTZ)

Fig. 1



R = DIA. OF CABLE X 12

r = DIA. OF CABLE +.010

$X = \frac{\text{DIA. OF CABLE}}{4}$

BENDING ARBOR
MAT'L. WOOD

Fig. 2