

OVERVIEW

The following discussion has been prepared in response to a number of inquiries on the concerns of pulling coax cables into conduits.

FACTORS TO CONSIDER

General Concerns

There are many variables that one must consider in planning a conduit pull. These include the size, strength and number of cables being considered for a given size conduit. The initial payoff tensions on the cables, the coefficients of friction of the surfaces involved, and the geometric layout of the conduit, the calculations for the pulling tension and sidewall pressure on the cables are quite complex. It is not the intent of this discussion to go into the actual methods of these calculations, but rather to give some general recommendations for pulling coax cables in conduits.

Conduit Material

The choice of the conduit material will have a direct relationship on the frictional drag imposed on the cable being pulled in the conduit. High density polyethylene will typically exhibit the lowest coefficient of friction while metal conduit exhibits the highest. If metal conduit is being used, it should be checked for burrs at all joints.

Feeding Cable

In order to keep the pulling tension low in a conduit, it is desirable to have a minimum payoff tension especially when bends will be encountered. In fact, if the run is very difficult it may be necessary to hand feed the cable into the conduit. When conduit must be reached through a manhole, it is important that the cable be guided in with a chute. The liberal use of a pulling compound will reduce the frictional drag between the cable and the inner surface of the conduit. This reduction can have a major effect on pulling tension.

Number of Cables

The number of cables being pulled into a conduit will effect the forces imposed on the cables during the actual pull. The size of the inner diameter of the conduit and the outer diameter of the cables will determine the percentage fill of the conduit. Interference and tangling increases with the number of cables being pulled with three being a practical maximum.

Bend Location

If 45° to 90° bends in a conduit run are located toward one end, it would be advantageous to pull the cable into the conduit from this end. While tension builds linearly in a straight run, tension coming out of a bend increases as a multiple of the tension coming into the bend. To keep this

incoming tension low, the bend should be closest to where the cable is being pulled into the conduit. Conversely, the least desirable location for bends would be at the end of a run where pulling tension would be large.

Maximum Allowable Pull Tension

The maximum pull tension imposed on a cable being pulled into a conduit should not exceed the manufacturer's recommended value. If more than one cable of the same size and construction is being pulled together, their maximum allowable pull tensions can be added provided forces can be properly equalized. When actually pulling the cables into the conduit, a dynamometer or similar scale should be employed to assure that maximum tension is not exceeded.

Note: The maximum allowable pulling tension applies to straight pulls, refer to sidewall pressure for pulling around bends.

Jam Ratio

When three cables are pulled into a conduit, their relative position in the conduit, when being pulled around bends can change, causing a condition of "Jamming". The Jam Ratio is defined as the ratio of the conduit I.D. to the single cable diameter. $JR = \frac{D}{d}$ It has been established that if the $JR < 2.8$ or > 3.0 jamming will not occur or be greatly minimized.

Sidewall Pressure

Sidewall pressure is the radial crushing force exerted on the cable at a bend caused by the tension in the cable and the forced contact with the side of the conduit. The major variables that will affect sidewall pressure are pulling tension entering a bend, the radius of the bend, and the occupancy factor for the cables. All of these variables mentioned should be kept as low as possible.

Pulling Compounds

When pulling cables into a conduit, a pulling compound should always be used to reduce friction and avoid potential cable damage. There are many products that are available, including wax, polymer and soap base lubricants. The lubricant selected should be compatible with the cable jacket. Soap and wax based lubricants are not recommended for use with polyethylene as they may initiate stress cracking at some later date. Commonly available compounds which may be used with polyethylene jacketed cables include:

1. Gel (Ideal Industries, Inc.)
2. Polywater J (American Polywater Corp.)
3. Polywater G (American Polywater Corp.)

Each of the above lubricants was tested to confirm that it is not a stress crack initiator when used with polyethylene jackets. The test procedure was per ASTM D-1693-70, using the lubricant as the test solution. All were found acceptable.