HIGHLIGHTS - UNDERGROUND CONSTRUCTION TECHNIQUES

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Good Afternoon Gentlemen:

I feel I am conversing to an audience having a considerable level of expertise in underground construction. Therefore, it is my intention to limit my comments to lay terms instead of a highly technical presentation. I hope our comments today will contribute to your understanding and enlightment concerning the technology of underground cable television facilities. My colleague, Mr. Bird, will later cover some of the techniques in further detail. I feel we will only touch on generalities in our discussion as there are many facets of concern in the topic matter before us.

With the continuing pole rental increases, difficulty in obtaining pole contracts and, in some cases, the requirements of franchises and pole contracts, underground cable installation is becoming more common throughout our industry. Beautification groups demand it, public utilities are headed more and more in this direction and cable operators are receiving constant pressure to adopt this method of plant installation.

Although underground installation has been practiced for years by the utility companies, it is a relatively new concept for the CATV industry. And, as with anything we lack experience in, hesitancy, apprehensiveness and phobias exist.

COST CONSIDERATIONS

Gentlemen, if you don't have to go underground with your cable facilities, just simply don't do it! However, if for physical and legal reasons you are forced to consider installing your cable facility underground, then by all means check your bank accounts - because I can assure you it is an extremely expensive venture and the costs involved are not consistent with the revenues generated by today's cable system rates and accepted amortization schedules.

I recognize that in the future, we are definitely going to have to anticipate and construct many miles of underground CATV facilities. However, I find that many of our constitutents generally approach underground construction with attitudes and cost projections based on overhead construction experiences from their past. This is the first major error that many of us make when anticipating underground construction. I personally have found it extremely difficult to develop and forecast accurate financial projections and underground construction schedules. This is particularly true where construction is anticipated in major metropolitan areas such as New York, Chicago or other top 100 Market Areas. One of my colleagues today on the panel has/or will touch briefly on cost factors involved with placing underground facilities. However, I feel it prudent to mention some of the more difficult cost factors involved with underground construction. The following areas of concern should be approached with diligence, and experience in order to develop accurate cost projections. They are:

1. Cost of developing right-of-way and easement.

2. Cost of concrete or pavement cutting, boring and trenching. This is particularly true in areas that are highly developed and covered with sidewalk and/or paved streets and alleys; i.e., we find that in California many of our backyards where utility easements are available are also enclosed in brick or wooden fences thereby causing a considerable amount of variables in finalizing cost factors.

3. Cost factors involving the labor and material for the project itself.

4. Cost factors involved with maintaining on-site supervision when the facilities are being placed in joint trench facilities. This is particularly true where other contractors are working in common facility over a longer period of time. Unless the cable company supervises and maintains someone on the site, the chances of damage to conduit or cable are extremely high. We find it to be an almost necessity to maintain someone at the construction site until all activities have ceased and the conduit or cable is buried.

5. Cost of cover-up, impacting the fill, blackcapping and/or landscaping.

ENGINEERING CONSIDERATIONS

Most of today's operators have generally experienced engineering which involved overhead plant facilities and some of you have encountered underground construction in areas where engineering considerations are similar to those of the overhead plant. However, I wish to point out that in many of today's metropolitan and urban areas the engineering prints and concepts for an overhead plant cannot generally be used in order to obtain the necessary permits and authorizations to place your facility in private or municipal-owned rights of way beneath the surface.

Experience has shown that a certain amount of civil engineering practice is necessary in order to properly design and sketch the underground facility. This is generally true where the municipal authorities are concerned for other utilities that may exist beneath the surface, such as water, gas, power and telephone, particularly if the cable entrepreneur is the latecomer. In this case, accurate and well-designed engineering sketches must be prepared in order to obtain the necessary authorizations to uncover the streets, bore under sidewalks, etc. While the engineering of the electronic facilities remain similar to the overhead plant, we find the underground physical design to cause almost as much concern and it should be accomplished by engineers having a mechanical or civil engineering background.

If any of you in the audience are planning on constructing facilities in some of the more developed downtown areas, I would suggest that you attempt to hire individuals who have had experience at designing and placing underground utilities when augmenting your staff. People with this type of background and experience are available in most communities. We have found a considerable amount of assistance from former retired telephone plant engineers or municipal civil engineers who would welcome the additional income.

CONDUIT -- WHY

We at the Cypress advocate and construct most of our underground cable underground plants with conduit. We recommend and advocate its use generally because we feel it provides the convenience of future maintenance and refurbishing. Additionally, we feel that there may be the potential possibility of additional future revenue generation by having the conduit placed to enable routing to all homes in new developments and tracts.

As an example, in the latter 1800's the city of New York franchised various entrepreneurs to place conduit within the streets of New York. Today, these conduits and right-a-ways are highly overburdened with communication facilities. However, if it were not for the early development of these communications paths the installation of cable and telephone facilities would be almost an impossibility. In California for a cable operator to consider construction of a cable system after a tract or housing development is fully developed with paved streets, concrete block walls, etc, we must anticipate a tremendous increase in the cost factors that I mentioned earlier. Therefore, we feel it advisable to attempt to get conduit facilities installed at the time the joint trench facility is opened, even though some costs and carried interests are generated until the cable plant is installed and activated. Having the conduit installed at an earlier date will allow the installation of cable and electronic facilities when the tract is fully developed and when CABLE TV would be a financially successful endeavor. Additionally, the early installation of these conduit routes also allow installation without future complications of street borings and the enclosure of private property with fencing and landscaping.

CONDUIT VS. DIRECT BURIAL

Usually one of the more direct questions that one encounters in the decision-making process is whether or not the cable installation should be made with conduit and coaxial cable or whether the coaxial cable should be armored and placed directly without the use of the conduit environment. This particular question has caused a considerable amount of rhetoric in the past and I am sure will be even more controversial as the technology developes in the future.

Most of our telephone company colleagues today will recommend the placement of armored buried cable in their plants. They point out that with proper design, their systems can be planned for future growth, and technology changes. Most of the utility companies have had more than 30 years of historical documentation to prove that the properly designed cable facility can be buried directly without the concerns that I express. It has been my general experience, however, that the Cable TV and cable technology has been in a constant state of change. As an example: Most cable plants placed five years ago, today will not handle 20-channel two-way transmission that the present industry is recommending. In many cases, we already are considering the refurbishing of systems constructed within the last five years.

I feel that todays' embryonic cable technology has not yet developed in comparison with the telephone-type cable. Additionally, our comrades in the utilities companies are not making use of extremely broadband, coaxial RF transmission techniques, therefore, it is difficult to compare the two

technologies in order to arrive at a conclusion. I feel that the advantage of having the capability to remove and refurbish today's cable facilities will far outweigh the cost factors of having to completely retrench and reconstruct the plant for future "state-of-the-art" changes.

There are areas where direct burial of CATV facilities should be considered, they are:

1. Rural areas where long cable runs are involved.

2. Existing tracts or developments where economics of cable operations prohibit the placement of conduit type facilities.

3. Underdeveloped areas where extensive streets and sidewalks have not been developed.

POLYETHYLENE VS. POLYVINYL CLORIDE CONDUIT

Once the posture and necessity for an underground plant is decided, we generally face the various questions of materials to be used in its construction. One of the first considerations will be the type of conduit that should be used if conduit is anticipated.

In general, there are two types of conduit configurations that are widely accepted by the industry, they are: Polyethlene and Polyvinyl Cloride which is sometimes referred to as PVC.

Polyethylene usually comes in 300 ft. rolls or shorter; it is a soft and semiflexible material.

Its advantages are:

1. Extremely easy to place in trench with a minimum amount of labor.

2. Can be bent to make corners and curves without special elbows and plumbing. However, it requires special coupling and sealing methods.

3. It is generally cheaper and quicker to install.

Its disadvantages are:

1. It is hard to handle and store. It is bulky and difficult to ship from manufacturer to consumer.

2. It cannot be glued or sealed like the PVC due to its inherent properties. One must consider the use of heat shrinkable tubing or splicing sleeves which are especially made for installation.

3. It can be easily collapsed by rocks and pressure if care is not undertaken in its installation. One must be careful to not purchase extremely thin-walled conduit when polyethylene is used.

4. It is difficult to use when sharp bends and short radii are encountered in the trench or right-of-way. Various configurations of flexible conduit and adapters must be considered in order to make a watertight environment.

PVC

PVC is a space-age material presently being used for water-pipe, containers, and other industrial products. Its advantages are:

1. It comes in straight 10, 20, and 30-ft. sections which are easily shipped and stored.

2. It can be easily adhered-to or glued by special solvents allowing an effective seal from hostile environments.

3. It is manufactured with preformed splices, bends and sweep radii which are necessity in order to pull the coaxial cable.

4. It is easy to plumb and makes a very neat installation.

5. It presents a smooth even surface in order to facilitate pulling the coaxial cable.

Its disadvantages are:

1. Generally costs 20 to 30% more than polyethylene.

2. Requires more labor to install.

3. Requires consistent chemical properties and wall thickness or it can be easily shattered by rocks or sharp blows of the worker's tools.

Generally, in our operations, we prefer to use PVC type conduit. However, in sandy areas and where economics play an extremely important factor in its construction, usage of polyethylene conduit is widely accepted as a substitute.

Whether PVC or polyethylene conduit is used for underground facilities one should be extremely careful to assure that it is continuously sealed from rocks, mud, water and foreign material. These cautions must be observed both during the installation of the conduit and after the installation of the cable.

CONDUIT TRACING AFTER INSTALLATION

As I mentioned earlier it is sometimes advisable to install conduit prior to the installation of the cable and electronic facilities. This is usually the case when a tract is being developed and sold over a long period of time and the utilities generally are placed at a date prior to the construction of homes and dwelling units.

It is general policy within our company to install conduit in these tracts at a time when the joint trench is opened. However we have encountered various problems when the cable and electronic installation is made at a later date.

Some of these problems have been:

1. Muds, water and rocks in conduit preventing the pulling of cable.

   To prevent entrance of foreign objects and water entering the conduit, it is necessary to seal the conduit properly during its installation and thereafter.

2. Broken conduit.

3. Lost conduit.

   a. Many times after these problems have been solved, we find it impossible to trace the conduit routes under the surface.

   In all installations you should attempt to keep conduit units to 300 ft. using access boxes, to enable pulling cable without excess tension, and to also enable later removal and replacement.

This is particularly true when streets and landscaping have been completed and the actual conduit route has been lost.

Whenever conduit is placed, it is advisable to assure that a pull wire or rope is installed. This will enable later pulling of the coax. We have found it helpful to place a stainless steel wire (.045 lashing wire will suffice) in the conduit at the time of installation. This wire can be used later to pull a heavier pull line through the conduit. However, its most important aspect is that one can attach a signal generator to the wire and with the use of a pipe tracer or metal detector one can trace the conduit routing under the surface of the ground. This can be most helpful in finding conduit breaks and routing. Therefore, I would recommend inserting a metallic conductor whenever a conduit is placed without immediate coaxial installation.

I would like, at this time, to turn the presentation over to my colleague, Mr. Bird, who will continue with the discussion.

Good Afternoon Gentlemen:

Underground installation can open Pandora's Box, or at least give us a good look inside. And unfortunately, we do not have a history established on the few systems with underground plant. Consequently, there are numerous areas of unanswered questions such as, maintenance, electronic design, type of cable, direct burial cable versus conduit and installation, to name a few. Each of those areas and many more would be a subject to itself. However, it is the installation technique I would like to address in this presentation.

TRENCHING VS. PLOWING

There are two methods of installing buried cable, plowing and trenching. It has been suggested that the plowing method be used when the soil is sandy and relatively rock free, but there are definite disadvantages in using the plowing method regardless of the type of soil. Plowing does create a mess.. The trench is dug too quickly with total disregard for whatever other facilities are underground. It is true the workmen doing the actual digging should contact all the people who may have underground facilities in the area. But, it is generally impossible to locate every drop, power feed, water pipe, etc. which has been buried. Consequently, something is constantly being cut, work stopped to enlarge the hole for repairs, a mad customer or potential customer, strained relations with a utility company, time lost and in the case of a water pipe, a large muddy hole, not to mention the cost of repairs.

Therefore, the plowing method should be restricted to areas which are rural or to new housing developments where underground installation is being originated and nothing has been placed underground up to that point.

Trenching, on the other hand, is much slower, but because it is slower, the problems I have previously mentioned are less likely to occur. The trencher operator is standing behind the machine and is able to observe where and what he is digging.

Also, the trenching method allows the operator access to confined areas which would be impossible to dig with a plow such as close to walls, fences, etc. Trenching, of course, is the only method which can be used when asphalt or cement removal and replacement is required. This is due to the confined working space and the necessity of leaving a 2" to 4" shoulder for paving replacement.

After the trench is opened, a 1" to 2" sand bed must be placed at the bottom of the trench as a cushion for the cable. The trench should be inspected for any sharp rocks or other objects which may be protruding from the sides. Those, of course, should be removed in preparation for the cable.

CABLE INSTALLATION

As to the installation of trunk and distribution cables, the practice of unreeling the cable parallel to the trench and then lowering the cable is a poor practice. While the cable is on the reel it is afforded the maximum amount of protection. To unreel the cable and place it alongside the trench is to expose it to abuse from the men and/or equipment working in the area. I am referring, of course, to direct buried cable. When using conduit this problem does not exist as the cable is fed directly into the conduit. When placing direct buried cable into the trench, the reel should be placed at the head of the trench in such a manner so the cable unwinds from the bottom. The pulling mechanism, should it be a pulling reel, take-up wench or whatever, should be located as near the other end of the trench as possible. The pulling cable is then attached and the cable pulled directly into the trench at a pulling speed not to exceed 60 feet per minute. A workman is positioned at the cable reel to assist the cable from the reel and to perform a visual inspection of the cable as it enters the trench.

After the cable has been placed into position it should be covered with another 1" to 2" layer of sand and then the trench backfilled and tamped completely.

When using conduit the same trench preparation and installation methods should be used. In the event of conduit usage, I recommend that an empty conduit placed in the trench of adequate size to accommodate two extra cables. This may sound economically extravagent, however, even today we are uncertain as to the extent of services we can or will be required to provide in the future. This extra conduit will provide for future system expansion.

This extra conduit should be brought well into each pedestal and capped to preserve its integrity. When using conduit in underground systems further precautions must be observed.

A lubricant must be applied liberally to assist the cable through the conduit. Also, cable pulling tensions according to manufacturers specifications must be adhered to, and pulls in excess of 300 feet should be avoided due to possible cable damage. It is also recommended that small holes be bored in the conduit at low points to provide a drain for moisture which may accumulate.

PEDESTALS

I won't argue the merits of flush mounted versus upright or exposed pedestals as this is usually dictated by the franchise requirements. But regardless of which method is permitted, one of the most important considerations is weather-proofing. Moisture is a constant source of trouble in an underground system and special precautions must be taken to protect against it. In a total underground system the use of cement water boxes as a protective housing is common in conjunction with a plastic capsule to house the equipment. This practice and the use of heat shrinks on the leads has proved to be satisfactory in most cases. However, this presents the problem of condensation. Since we are airtight, the plastic has the tendency to "sweat" with no escape for this moisture. This can be eliminated through the use of a small cheese-cloth sack of calcium chloride placed inside the capsule to absorb the condensation. This also holds true when using upright plastic pedestals.

Considerations for upright pedestals should include immunity to weather and soil conditions, minimum maintenance such as painting, attractiveness and protection against vandalism. In both methods, adequate lengths of cable should be left in the housings to accommodate future maintenance requirements such as connector replacement or repositioning of equipment.

SPLICING

When initially installing the trunk and distribution cable the need for a splice should never occur. The necessity of a splice at this time is inexcusable. Customizing cable lengths to accommodate distances between amplifiers is necessary and must

be done throughout the plant. After each reel is swept in the shop, it should be designed for a specific location and a record kept of its characteristics and where it was placed.

However, after initial installation it is inevitable that the cable will be cut and a splice required. When this occurs, a pedestal or water box should be installed at this location and the splice placed inside this housing. Should the splice occur in a feeder, a directional tap should be installed which can then serve as a test point in case of later trouble in this line. This may seem economically unfeasible, however, the best splice made by a technician will, at some time, be a source of trouble and the quicker and easier it can be checked, the faster you can clear the problem. On the other hand, if you have to locate a splice underground, dig for it and then repair it, the cost of labor has more than exceeded the investment of a pedestal or directional tap.

RECORDS AND MAPS.

I would like to touch on one other aspect of underground plant which, is too often overlooked - and that is accurate maps and record keeping. By going underground the advantage of physically observing the plant is lost - making accurate maps and records even more mandatory and valuable than before.

The construction supervisor should have a complete set of maps with him on the job site at all times as should each of his foremen. As construction progresses these maps should denote the cable, the distances between amplifiers and other equipment and their exact locations in respect to permanent landmarks. After construction is completed these maps are compiled into an "as-built" map and copies given to all maintenance employees. As changes occur in the system these maps should be immediately up-dated. Records should include accurate flow charts on each amplifier, equalization methods, cable characteristics and a maintenance record on all amplifiers. I cannot stress strongly enough the importance of accurate maps and records in an underground system. This may force the system operator to create a new position on his staff to maintain this information, but it will certainly be one of his better investments.