



**Remarks of Dale Metzinger
Consulting Engineer
OG&E
at the Annual Meeting of the AEIC
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Richard R. Grigg: Two incidents this year, a steam line break in New York and the bridge collapse in Minnesota, have drawn the public's attention to the fact that some infrastructure in many of America's cities is showing its age. The same is true for many of our underground electrical systems serving major cities. And it's taking more of our time and our resources to keep those systems operating reliably. AEIC's Cable Engineering Committee is a group of electrical engineers dedicated to not only keeping older underground systems operating reliably, but also insuring that new underground cable systems are manufactured with the best materials possible and constructed to the highest electric utility standards. To that end, the AEIC Cable Engineering Committee writes those standards. In fact, the primary work output of the Committee is the cable engineering specifications and guidelines that are published by the Committee and distributed by the AEIC office to users all over the world.

Representing the Cable Engineering Committee this morning is Dale Metzinger, its Chairman. Dale is Senior Engineer at OG&E and this is Dale's second year as the Chairman. We appreciate the work that he and the entire Committee have accomplished. Dale, I believe you're going to take us through the high stakes world of underground distribution. Please welcome Dale Metzinger.

Dale Metzinger: Good morning. Boy, wow! The last three days of presentations gave you a lot of options, solutions and suggestions. But the hard part is developing a plan, and implementing it.

I'm going to show you one way to handle your options, and it's by an F16 pilot. The pilot had three options, take the plane back to the runway, refire the engine, or bail out. *(Mr. Metzinger played a videotape of an F16 airplane that had a flame out and the action that if the pilot failed to take would result in dire consequences.)*

See how easy it was to handle those options? Eject! Eject! But anyway, let's get back to underground cable *(laughter)*.

Underground cable consists of transmission cables up to 345 kV, cables that are installed in a network in high load, intensive areas like downtowns and mainly consists of PILC cable. Another form, wide area underground distribution cable, covers everything from 5 kV to 46kV, and it mainly serves residential and industrial customers and etc. In this visual, you can see the polymers that are used in its construction.

Even though all systems have aging infrastructure, I will limit this presentation to underground distribution cables used to serve wide area residential and industrial customers. Utilities have thousands of feet of this type cable in the ground, miles of it. And, I'll digress just a little bit and comment on network underground cable. It is lead covered, and a recent survey at OG&E indicates a lot of this 70 and 80 year old lead covered cable is showing stress fractures in the lead. Once water gets into a PILC cable – that's it, it's out. And, oil impregnated paper insulation doesn't help.

This slide shows the cables that were used in the 50's and 60's. And some of its deficiencies were that raw material was in its infancy and thermoplastics were used. Those thermoplastics had composition problems, etc.

And cable design lacked a lot. The design was bare concentric neutral, and it was tinned, which caused a corrosion problem. And the cable had no jacket, so water could get to it easily. In this picture, you can see the neutral corrosion on the conductor, the neutral conductor there at this location.

Manufacturing had a problem, too. It was a two-pass extrusion process. I won't get into that, but it didn't help at all in manufacturing these cables. And, of course, the process was water cooled. Utility industries experience, though, with these early cables was with water tree growth. Water trees – or small cracks in the cable that look like trees – turn into electrical trees, and then failure. And corrosion of the tin bare copper neutral was definitely a problem. The cables also had poor insulation voltage withstand characteristics. And then, of course, there was the problem of water ingress. Here are some failures in underground distribution cable. Since a lot of our system is direct buried, we go down and repair a foot of it upon failure. And so far, it's been a cost effective method for us. But, with labor and material, and in certain soils, that cost is going up we may investigate other options. Notice in this photo that there's a water tree inside the insulation.

Who was the force behind cable improvements? Of course, it was the AEIC Cable Engineering Committee. In 1960, when these failures started occurring, these dedicated utility engineers really got involved. And their work is appreciated by today's cable engineers. The Committee developed and wrote many standards that were used worldwide, and campaigned for the improvement of distribution cable life. Instead of experiencing 35 to 40 years service for 60's and 70's cables, we are now working towards 50 or more years service on the new cable, which we helped create.

Today, we are working with cable manufacturers to help reduce the contaminants in the raw materials that Borealis and Dow use in the cable manufacturing process. And, there's the insulation of the new cable (*referring to the visual*). It has higher breakdown voltage and better semiconducting shields, which means greater reliability. The cable is jacketed now, which minimizes neutral corrosion and mitigates water ingress. And finally, the latest improvement was the conductor strand block of stranded conductors. This helps keep water out of it, if the cable happened to get cut or damaged. One other thing in the manufacturing process that was improved – it is now a one-pass triple extrusion. In other words, they extrude the shields and the insulation all in one pass, which helps keep it cleaner. And last, a nitrogen cooled process was definitely an improvement instead of water cooled.

However, utilities still have a big problem. Underground cable is out of sight and out of mind. And, cable becomes 40 years old without any notice. 1970 cable is now 37 years old, and a lot of it is underground. Year by year, the engineer sees an increasing number of cable failures and reliability indices get worse.

What do we do with aging underground distribution cable? It is aging and failures are not going away. In fact, as shown by many utilities and consulting firms, the failure rate will get worse per mile of cable as it ages. U.S. utilities have millions of feet of old cable in the ground. For instance, the replacement cost to a utility with approximately 7.5 million feet of 1970s cable – that's one decade – is between \$113 and \$190 million.

Depending on budgets, the cost may have to be spread out five to ten years or more. How do we address this monumental issue and what are the challenges? One answer is budget availability. And by the way, I did a quick survey of the Cable Engineering Committee members, and this is probably number one on their list, trying to get a hold of some money. And you guys are the ones in control (*laughter*).

Records availability is bad, because we're depending on old records, and a lot of those old records are not really that good. Manpower is a problem, both for engineering and construction. What to replace? When to replace? That's a big issue. And I'll show more about that later. Replacement is a big cost. Should a utility be proactive or reactive in addressing cable failure? Do you go in just because it's getting old? Maybe! Do you use O&M to do predictive testing and assessment? Should fault circuit indicators be used? And to this point, that's where I was glad to hear Mark's (*Williamson*) comments on AMI. It might be advantageous to have AMI, because we can identify one span between two transformers serving residential and we know where to go to repair it. We

don't have to do any cable locating, because we can see those meters go out instantly. It could be a transformer, but at least it will cut down on restoration, and the restoration time indices will improve.

Should fault circuit indicators be used? And finally, cable rejuvenation is an option for some utilities. At OG&E, we have a lot of solid #2 AL cables, so we don't have any option there. We just replace the cable if it's that bad.

Let's consider one challenge. What to replace? Well, you can see that there are quite a few issues besides money. There's age, failure rate, number of customers, etc. Let's consider age of two underground additions on the OG&E system. The vintage cable is 1971 and 1972. You can see (*referring to the visual*) the red, blue and yellow lines. Red indicates multiple failures. So, those spans had more than one failure. Blue is one failure. Yellow indicates those spans of cable that did not have any failure since 1998. There are 260 customers on this UG addition, and 26,000 feet of cable. And its cost will be from \$392,000 to \$600,000 to replace it, since its direct buried. Would you do a proactive repair? Well, on this case we did a proactive repair and replaced not only the multi-failure cable, but also the good cable, because as you noticed, the costs are lower per foot if you do a large area when you're contracting.

Here's the example of the same vintage cable, right down the road from that previous subdivision. And we have had only two spans that failed since 1998. We definitely wouldn't want to replace this vintage age cable on this addition. So, the decision is what? Replace one span as it fails? Well, not necessarily. I did a study and found out that a lot of these cables that had the first failure would go two or three or four years, up to six years, before they would have a second failure in that same span. And so, do we wait for further failures or start proactive maintenance? I don't think so, not on this one. But, it depends on the engineering staff that is looking at it and what type of system you're dealing with. For instance, some utilities, like San Diego Gas and Electric, pretty well have all their system in conduit. So, if they have one of these failures, they have no choice but to just go out and pull the wire out and replace it. They put a lot of conduit in the ground. But a California law, I think, dictates that they have to pull that cable out. I just hope that it doesn't happen to us, because we won't do it with direct buried cable.

In this brief encounter I've shown you just one example of the cable engineer's dilemma, and that is what to replace. Each challenge has unique variables, which the engineer must consider. Each challenge has many resolution options. And depending on the challenge, the cable engineer has varying degrees of control over process and outcome – money! And I would like to go through them all, but time doesn't permit. However, I would like to point out some important conclusions.

Let's face the facts, failure rates of aging cable – underground primary cable – will increase, there's no doubt. Utilities must budget consistently for replacing aging cable. Replacing aging cable infrastructure is no short term. Utilities' methods will vary when replacing aging cable. Management must promote better technical recordkeeping. If they don't have fault circuit indicators, utilities may have to consider them until long-term cable replacement is completed, and that's what we're doing. Utility executives must campaign for capitalizing cable testing assessment techniques.

Right now, there are two or three vendors out there that provide cable testing. They can do an assessment on 160 acres, for instance, and maybe 20% of the cable needs to be repaired. Well, you can only capitalize the construction part. So, you have a cost of the testing that is still O&M. That's the prevailing thought, I think. I may be wrong.

And, last but not least, the Cable Engineering Committee will direct more of its energy toward guides addressing aging infrastructure, continue work for better cable design through specifications, and work together as a team to promote best practice methods for utilities. It's easy to see where we were, but difficult to see where to go.

One final note. The Cable Engineering Committee is in capable hands for 2008. The Chairman will be Richie Harp, with Oncor – and Richie, I'd like you to stand up. He will be your new leader in the Cable Engineering Committee. Thanks, Richie. Vice Chair will be Mike Smalley, of We Energies, and the Second Vice Chair will be picked (*Ted Nishioka, from Arizona Public Service was selected for the Second Vice Chair position*). The Cable Engineering Committee has consistently met its goals. You know, 85 to 90% of the members attend consistently and we have 30 members approximately. And it is increasing. And at this November meeting, we'll have eight guests seeking new membership into the CEC. They have to attend two consecutive meetings to be considered. And that's about it. Thank you.

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