History of Secondary Cable Designs

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ComEd Background

- System Data
- Service Territory
- Customer make-up
- New Construction Activity
- Service Delivery Tariffs
- Secondary Cable Designs
- Secondary Cable Performance
- User Specification
Service Territory
• 20% of the State of Illinois
• 11,411 square miles
• 3.7 million customers
• Peak Demand: 22,200 MW
• 464,000+ Transformer Locations
ComEd Energy Delivery Regions

- Chicago-North (CN)
- Chicago-South (CS)
- Northeast (NE)
- Northwest (NW)
- Central (CE)
- Southeast (SE)
- Southwest (SW)

Office Locations

- ComEd Offices
- Regional Headquarters
- Local Area Offices
- Reporting Centers
- Exelon Generating Sta.

*Not all Chicago offices are shown*
Customer Profile

• When they hear "ComEd", many people first picture "the Loop", the downtown Chicago area full of skyscrapers.
• However our service territory contains *everything* from high-rises to suburbia to rural farmland.

• **High Rises, Vaults, Network Centers**
  • Underground Residential Distribution
  • Rural Line Extensions, Phase Converters, Irrigation Systems, Stray Voltage
Customer Profile  
(continued)

• Natural gas is readily available for the majority of ComEd’s customers.

• The typical residential home uses:
  – Gas heat
  – Gas water heating
  – Electric Central Air Conditioning
New Construction Activity

- 50,000 “New Business” Tasks Annually
- 20,000+ Single Family Homes
- URD Subdivisions

- Commercial Development follows Residential Development
- New Business Capital Work: $120M ±
Service Delivery Tariffs

- **Community Bank** serving multiple customers from an easement or road right-of-way.
- **Electric Service Station** (ESS) that serves just one customer.
- The Commercial & Industrial customer's demand is the basis for determining what they are entitled to as **Standard** (for free). In general, the higher the demand the more they receive as Standard.
  - An ESS on their property vs. a Community Bank.
  - Various utilization voltages from 208 volts to 345kV
- The ultimate design built to provide service is referred to as their **Required**.
Service Cables

• **Non-Residential Customers served from:**
  – **Community Bank:** serving multiple customers from an easement or road right-of-way.
    • Customers typically own the underground service conductors from a community bank. ComEd owns overhead service cables.
  – **Electric Service Station** (ESS): serves just one customer.
    • Customers own all service conductors whether they are overhead or underground.

• **Residential:** ComEd typically owns and maintains both overhead and underground service cables to residential customers.

• Customer owned cables sized for switch (**NEC**)
• ComEd owned cables sized for demand (**NESC**)
Secondary Cable Designs
for Residential Customers
- the past -

- In the late 1920s, 1/C and 3/C copper, rubber insulated, lead sheath cables were installed in high cost residential areas where appearance was the dominate factor and cost was not a primary condition.
- These installations were paid for by developers, and were costly compared to overhead.
- These systems made use of high cost components, including buried transformer vaults similar to what is used in the high density urban areas.
- However, while the engineers of that time have long been forgotten, these direct buried installations have formed the basis for the low cost systems in use today.
Secondary Cable Designs
for Residential Customers
- the past, continues -

- In the 1940s, following the depression years, new residential development increased and the design of curvilinear subdivisions with irregular lots was initiated.
- Developers of above average cost housing triggered the demand for lower cost distribution power components.
- It was during this period, the concept of lower cost, simplified underground distribution design began.
- Components of the 1950s were designed for direct burial which included concentric neutral primary cables and GR-S rubber insulated, neoprene jacketed secondary cables.
- Expansion of the underground system for residential use was due almost entirely to the reduce cost differential between overhead and underground construction.
1Ø pad-mount transformer with 600 volt neoprene jacketed cables
Joint Trench Construction
- the beginning -

- In the residential designs up to 1960, electric cables and communication cables were in separate trenches because of the Illinois Commerce Commission requirements of 12 minimum separation.
- In 1960, CECo and IBT coordinated a trial installation of primary and secondary electric cables and telephone cables in a common trench, but still maintaining a 12 inch vertical separation.
- Either CECo or IBT would install both company’s cables.
- Because of similar appearance of the CECo 1/C neoprene jacketed secondary cable and the IBT multi-conductor cable there was a need to change the physical appearance of the secondary cables.
Joint trench cont..

- 3 types of secondaries were evaluated during the 1960 trial:
  - 2 x 1/0 CU Ø + #2 CU ±, ribbon type secondary cable with 130 mil PVC insulation. One phase had white stripe for power cable ID.
  - 2 x 3/0 AL Ø + 1/0 AL ±, with 125 mil of XLPe insulation, and triplexed. Phase identification by raised ridges.
  - 2 x 1/0 CU Ø with 78 mil RHW moisture & heat resistant rubber insulation, a #2 CU concentric neutral, with an overall 62 mil yellow-colored PVC jacket.
- The ribbon type secondary proved most acceptable from an overall cost and workability standpoint.
- A policy was created that either the telephone company or CECo would perform all the trenching and backfilling operations at no additional charge to the developer.
- In 1961, the Illinois Commerce Commission approved joint trench construction with random separation, which we continue today.
Jake & Elwood

Primary + secondary cables

telephone
2 x 1/0 CU Ø + #2 CU ±, ribbon type

2 x 1/0 CU Ø + #2 CU concentric neutral

2 x 3/0 AL Ø + 1/0 AL ±, triplexed
Ribbon PVC Insulation  
--circa 1960--

- ComEd’s 1st generation identifiable power cable for joint trench applications.
- 3 aluminum conductors with PVC insulation laid flat and parallel to each other.
- Conductors were separated by a thin web to facilitate separating for splicing and terminating.
- This cable was readily identifiable from the standard round telephone cable.
- After a few years of use, problems with cold weather cracking resulted in a change to a different product.
Triplexed XLPe Insulation

-circa mid 1960s-

- ComEd’s 2nd generation identifiable power cable.
- Continued with AL conductors but changed to XLPe insulation per IPCEA Pub. S-66-524.
- Triplexed design with yellow-colored neutral conductor maintained an identifiable electric cable in joint trench random lay.
- Improved performance over PVC insulation.
- 4/0 AL Ø + 2/0 AL ± in Triplexed configuration for secondaries
- 3/0 AL Ø + 1/0 AL ± in Triplexed configuration for services
Triplexed XLPe Insulation

-mid 1960s to 1979-

- Use of this insulation was successful, but sensitive to trenching and backfilling practices.
- Even though clean fill was specified, rocks and new home construction debris frequently caused damage.
- Cables were pushed into trench by use of a shovel, which nicked the insulation.
- Failures were found at base of conduits, bottom of pedestals, and customer meter entrances.
- Also, new homeowners were anxious to landscape their property and un-willfully dug into the underground facilities.
Sodium Cable

1965 to 1970

• Sodium cable was introduced in 1965 as an alternative to copper or aluminum conductors as a cost savings.
• Projected savings were based on ~20% lower cost over aluminum.
• Phase conductors: 2 x 2/0 “CU Equiv.” XLPE insulation, 3 stripes for identification.
• Neutral conductor: 1/C 2/0 CUE HMWPE
• Silvery white in color with the workability similar to putty
• Required threaded connectors.
• Is a highly reactive material when expose to water
Sodium 600 volt Cable

2/0 “CU Equiv.” XLPE insulation
Environmental Alert

Exelon Energy Delivery Green – LL/OE Communication

Date: March 23, 2005          ED-EN-XXX          Effective Date: ASAP

Alert Type: Environmental Bulletin

SODIUM CABLES

Affected Department(s): Operations
Ruggidized Cable Design

• ComEd’s 3rd generation identifiable power cable.
• Began installation of ruggidized XLPe in 1977.
• Its been our standard for 26 years.
• Purchasing specification requires compliance to ICEA S-81-570, part 7 for abuse resistance.
• In addition, a maximum insulation diameter is specified for free striping with approved tools.
• Had an impact on reducing secondary cable failures.
600 volt Cable Performance

- From 2001 to 2004, secondary failures comprised ~ 10% of all UG failures.
- Over 10 years ago, secondary failures accounted for ~ 50% of all UG failures.
- High % of failures occur in the first few years following initial installation from continued construction work in the subdivision.
- In addition, the homeowner is anxious to landscape their property.
Number of 600 volt Failures from 2001 - 2004
Time to Failure from Date of Installation
for 600 volt Cables
from 2001 - 2004 failure data

Start of Ruggidized
Temporary repairs following cable faults

- If one conductor of 120/240 1Ø service is faulted, using the good conductor and this 2:1 transformer will temporarily return power to the customer until permanent repairs can be made.
- Cable in flexible conduit laid on the ground will also provide a temporary repair.
Utility’s Material Specification

- Utility Engineers have control of writing conformance requirements to be sure 600 volt cable is shipped in high quality condition.

- Items to consider:
  - Reels shipped in “roll-out” position for proper fork truck handling. Make sure your storeroom operators know how to pick-up cable reels.
  - NEMA Class 2 wrap will identify fork truck damage.
  - Cable ends secured to shipping reel and protected from damage.
  - Water tight end seals. Periodically perform a dunk test to check effectiveness.
  - Perform periodic audits of Supplier’s facilities. Refer to:
    - AEIC CG8 Guide for an Electric Utility Quality Assurance Program for Extruded Dielectric Power Cables