

In Service Performance Of EPR Cables Installed In The MLGW Electrical Distribution System

***Insulated Conductor Committee
Subcommittee D – Generating Station And Industrial Cables
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Abstract

Provides brief background relating to the decision to install EPR insulated cables rather than HMWPE and XLPE cables, 30 year performance history of EPR cables, and field aging studies performed at MLGW.

Early URD/UD System

- **Earliest URD Customers Served By PILC Cable**
- **Expensive And Time-Consuming To Install**
- **A Good Service History**

Early URD System

- **First Extruded Dielectric (URD) Cable**
 - **Began Installing In 1967**
 - **#2 AWG Copper Primary Conductor**
 - **240 Mils HMWPE**
 - **Copper Concentric Neutral**
 - **Unjacketed**
 - **Direct Burial**
 - **Operated At 12 kV & 23 kV ϕ - ϕ Voltage**

Early URD System

- **By 1973, with only six (6) years of field service, the HMWPE cables had a failure rate of 4.24 failures per 100 conductor miles per year**
- **By 1976, the failure rate was 16 failures per 100 conductor miles per year.**
- **This high, and accelerating, failure rate resulted in specifying XLPE cable insulation for all cables in 1976.**
- **By 1978, URD Cables Installed In Conduit**

Early UD System

- **First Extruded Dielectric (Feeder) Cable**
 - **750 kcmil Al Primary Conductor**
 - **240 Mils XLPE**
 - **Copper Concentric Neutral**
 - **Unjacketed**
 - **Mostly Installed In Conduit (Some DB)**
 - **Operated At 12 kV & 23 kV ϕ - ϕ Voltage**

Early URD/UD System

- **By 1980, XLPE Failure Rates Were Approximately (3) Failures per 100 Conductor Miles Per Year**
 - **(HMWPE Failure Rate Peaked In 1983, At 87 Failures Per 100 Conductor Miles, URD)**
 - **(XPLE Failure Rate Peaked In 1985, At 11 Failures Per 100 Conductor Miles, Feeder)**

Search For Reliability

- **Change Of Company President in 1978**
- **Focus Shifted From “Initial Cost” To “Life Cycle Cost”**
- **Sought To Determine Which Cable Designs And Materials Had The Greatest *In-Service* Reliability & History**

Change To EPR Based Insulation

- **After Significant Research, MLGW Chose A Cable Design Which Had:**
 - *Similar* design to cables with a near-flawless reliability history in shielded power cables dating back to the 1940's (35+ Years).
 - *Same* EPR base material and shielded power cable design since 1963 (16 yrs), with near flawless reliability history.

“Post 1980” MLGW System

- **Emphasis Placed On High Reliability Splices, Terminations, Connectors, Transformers, Cable And System Design**
- **“Post 1980” System Design Used For “Retro-Fit” Of “1967-1979 System” – With Approximately \$50 Million Spent To Improve Reliability And To Bring The URD System To “Post 1980” Standards.**
 - **“Retro-fit’ Cost Approximately 7-8 Times Initial Installation Cost (Inflation Adjusted)**

EPR Reliability

- **Failures From 1980 To Present (2010)**
 - **Impulse Failures (Lightning) – 4**
 - Note Two of the four lightning failures significantly damaged other equipment, pad-mounted transformers, arresters, pole.
 - **“Eat-Ins” – (Squirrels) – 4**
 - **Overloads – 2**
 - Both failures were on same circuit, approximately two weeks apart in time. This cable was subjected to 160% full load current for several days.
 - **Damaged During Installation – 2**
 - **Damaged On Reel Before Installation – 4**
 - **“Dig-Ins” – Undocumented**

EPR Reliability

- **Approximate Failure Rate Of
0.16 Failures Per 100 Conductor Miles, Over
A 30 Year Period; 0.0053 per 100 Conductor
Miles Per Year.**
 - **Does Not Include Splice, Termination And
Connector Failures**
 - **Does Not Include Failures From Abuse:
Overloading & Mechanical Damage**

Routine EPR Cable Testing

- **Because Of Very High Reliability Commissioning Testing Is Not Economically Viable.**
- **It Is Highly Unlikely That Commissioning Testing Would Detect/Eliminate In-Service Failures Of EPR Cables Used In The MLGW System.**

Routine EPR Cable Testing

- **Although The Reliability Of Splices/Terminations Is Not As Great As MLGW EPR Cable (Manufacturing Defects And Installation Workmanship), The Reliability Is Very High.**
- **Commissioning Testing *Might* Detect Workmanship Errors In Splicing And Terminating.**
- **However, The Cost For This Testing Is Many Times Greater Than Cost To Perform In-Service Repairs.**

MLGW Field Aging Test Project

- **Six (6) Different Cable Constructions**
 - **Three (3) Different Types Of EPR Insulation Compounds**
 - **Two (2) Different Wall Thicknesses (260 & 175 Mil Wall)**
- **All Energized At 23 kV System Voltage 13.23 kV To Ground**
- **All #2 awg Copper Primary Conductor**

MLGW Field Aging Test Project

- **36,000 Feet Of 260 Mil Wall Insulation**
 - **12k Feet Each Insulation Type**
 - **86 V/Mil Max Stress; 51V/Mil Average**

- **36,000 Feet Of 175 Mil Wall Insulation**
 - **12k Feet Each Insulation Type**
 - **112 V/Mil Max Stress; 76 V/Mil Average**

MLGW Field Aging Test Project

- **Alternating Current Breakdown Tests Performed On Field Aged Cables At Year 0, 2, 5, 9 Years**
- **Additional Tests Performed On MLGW “Standard” Cable At 10 & 14 Years**
- **ACBD Values Indicate Stabilization Near 400 V/mil**

MLGW Field Aging Test Project

Average AC Breakdown, V/Mil

260 Mil Wall Cables			
Year	Mfr "A"	Mfr "B"	Mfr "C"
0	685	384	485
2	473	424	501
5	596	354	354
9	405	358	389
10		396	
14		362	

175 Mil Wall Cables			
Year	Mfr "A"	Mfr "B"	Mfr "C"
0	816	452	536
2	726	452	433
5	517	483	451
9	422	416	391

Future Testing

- **Twenty-Two (22) Spans (8,139 Ft) Were Removed December 2008-January 2009.**
- **This Yielded 187 Samples Which Were Packaged And Delivered To Manufacturers For ACBD And Impulse Testing In April 2009.**
- **Currently (Patiently) Waiting For Completion Of Tests By Manufacturers.**
- **There Is Enough Remaining Cable In Service For Additional Testing.**

Conclusions

- **Near Flawless 25 Year In-Service History With EPR Insulated Cables At MLGW: 0.0053 Failures Per 100 Conductor Miles Per Year**
- **Excellent 47+ Year Industry History With EPR Cable.**
- **Because Of Excellent History/Reliability No Commissioning Or Routine Testing Has Been Shown To Be Required.**

Conclusions

- **Although Not Mentioned Earlier, Additional Cost For “Premium” Cables & Materials Is A Small Cost Of The Installed System; And Is A Small “Price To Pay” When Replacement Costs Can Be ~7 Times Original Installation Costs.**
- **Field Aging Studies Have Indicated Stabilized ACBD Values Near 400 V/mil.**

Questions & Comments

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