MPS Fused Cutouts
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IV. MPS Cutouts

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   b. Silicone vs. EPDM
   c. Core
   d. Shed pattern
   e. Fittings
   f. Hardware

2. Service advantages
   a. Domestic factory
   b. Storm capabilities
I. Cutout Design & Function
1. Function

a. Purpose
   • Over-current protection
     - System demand
     - Short circuits
     - Various fault types

b. System construction
   • Overhead distribution
   • All distribution kV classes
   • Commonly applied in front of transformers
   • Applied prior to beginning underground line

Video
http://www.youtube.com/watch?v=zAxGBHZtUM0&feature=youtu.be
2. Terminology

a. Common terms

• **Interrupt Rating**
  - Maximum short-circuit current the cutout device can interrupt, extinguish, and clear under standard test conditions

• **Basic Insulation Level (BIL)**
  - Measure of withstand for surge voltages such as lightning or system switching

• **Dry Arc**
  - Distance of the shortest path from line voltage to ground

• **Leakage**
  - Distance from line voltage to ground when the current path is along the insulation surface
2. Terminology cont.

b. Components

- Parallel-groove clamp
- Fuse support / body
- Center bracket
- Lower contacts
- Lower hinge
- Trunnion
- Flipper (under trunnion)
- Sleet shield
- Upper contact spring
- Upper contact
- Arcing horns / guide hooks
- Hook stick ring / eye
- Fuse holder / tube / door
- Fuse tube ferrules
2. Terminology cont.

• **Fuse holder**
  - Current interrupt rating specific
  - Filament wound tube to support fuse link
  - Reusable, but liner must be inspected after interruption
  - Arc energy used to convert synthetic liner to di-electric gas

• **Fuse link**
  - Selected by current rating and system coordination
  - Replaced after every over-current incident
  - Time / Current characteristics control melt speed
3. History

• General
  - Cutout patents date back to 1930
  - Up to mid 1990’s each manufacture had unique fuse holder dimensions

• Fuse tube
  - Bone fiber or fish paper
    - Problems with moisture absorption and swelling
    - Durability
  - S&C fuse tube design patented 1980 with synthetic lining
  - Current tubes are constructed from fiberglass

• Insulator
  - Porcelain devices
  - S&C silicone insulator patent filed 2002
  - MPS silicone cutouts 2010
II. Cutout Standards
1. Current Standards

a. IEEE / ANSI

- Institute of Electrical and Electronics Engineers Power & Energy Society
  - Shares developments in the electric power industry, creates standards for the development and construction of equipment and systems, and educates industry and the general public
  - Switchgear subcommittee is the controlling body for cutouts standards

- ANSI / IEEE C37.41-2008 Standard Design Tests
  - Power Frequency Dry Withstand
  - Power Frequency Wet Withstand
  - Impulse
  - Interrupting Test Series 1 – 5
  - Radio Influence
  - Temperature Rise
  - Manual Operation
  - Thermal Cycle
  - Bolt Torque

  - Tables specify test values for design tests listed above
  - Currently under revision with long term goal to roll C37.42 into C37.41

b. CSA – Canadian Standards Association

• **C310-09 Distribution Class Polymeric Cutouts**
  - References C37.41 & C37.42
  - Additional tests for polymer fuse supports, based on distribution insulators
  - Additional mechanical tests
  - Interchangeability clause
  - Bolt torque

• **Concerns with C310-09 Specifications**
  - Tracking & erosion test is at fixed 35V/mm leakage, not system voltage, penalizing high-leakage designs
  - Interrupt interchangeability of fuse tubes has no standard - annex A.5.4 suggests customers to inquire with manufactures

c. IEC

• **Used internationally in European, African, and many Latin American and Asian countries**
2. Evolution of Standards

a. NEETRAC
   • School of Electrical and Computer Engineering at Georgia Tech
   • Self-supporting, membership based testing & research center

b. ANSI / IEEE
   • C37.41 – porcelain cutout standard evolving to cover polymer cutouts
     - Currently under revision
     - Incorporating sections of C37.42
     - NEETRAC polymer working group has proposed recommendations to IEEE committee to include tracking & erosion, mechanical tests on fuse support and interruption at temperature extremes
   • C37.42 – phasing `out
     - Currently under revision
     - Many sections being moved to C37.41
     - Next revision most likely to be the last change

c. CSA
   • CSA 310-09
     - Test parameters should be reconsidered
     - MPS has not participated in this committee
3. Design Tests

a. Standards Tests
   • ANSI / IEEE C37.41-2008 Standard Design Tests
     - Power Frequency Dry Withstand
       Tests insulator design and construction by holding a specified voltage for a period of time

     - Power Frequency Wet Withstand
       Same as above but in a simulated high humidity or rainfall environment

     - Impulse (BIL):
       Tests insulation level to protect against surge voltages such as lightning or system switching

     - Radio Influence Voltage (RIV)
       Tests to ensure the design does not create electrical noise

     - Interrupting Test Series 1 – 5
       Tests the entire cutout system to interrupt different over-current conditions
3. Design Tests cont.

a. Standards Tests cont.

   - Temperature Rise
     Tests resistance factors (i.e. contact pressures, material selection and design)

   - Manual Operation
     Tests ability to function properly after 200 open and close operations

   - Thermal Cycle
     Tests design integrity during thermal expansion/contraction

   - Bolt Torque
     Tests hardware up to at 125% of nominal manufacturer-specified torque values
b. MPS Tests
   • 3 point bend – Test glass core rigidity
   • Water Diffusion
     – Tests fiberglass core integrity and silicone bond to core
   • Dye penetration
     – Tests fiberglass core integrity & end fitting seal
   • Torque
     – Tests crimp joint integrity and fiberglass core strength
   • Tensile test – Tests fiberglass core and end-fitting strength
   • Loadbuster – Tests mechanical operation using S&C Loadbuster device

c. NEETRAC proposed testing
   • Insulation Test (42 hr boiling water / steep front impulse / withstand)
   • Water Diffusion Tests (CSA 7.4)
   • Interruption Test Series 1 at +50 °C and -50 °C
   • Tracking & Erosion
   • Weathering - UV Aging
   • Long Term Deformation
III. Advantages of Polymer
1. Design Advantages

a. Material
   • Polymer types
     - PTFE – Polytetrafluoro ethylene
     - EPR – Ethylene propylene rubber
     - EPDM – Ethylene propylene diene methylene
     - SIR – Silicone rubber
   • Inherent resistance to pollution & are hydrophobic
   • Pliable material vs. brittle porcelain material
   • Weight differential (1:10)
   • Engineered material – easy to mfg.

b. Insulation
   • Increased leakage
   • Greater dry-arc distances lead to higher kV flashover levels
   • Better performance in polluted environments
2. Installation Advantages

c. Installation

• Durability & Handling
  - No possibility of chipping
  - Higher impact resistance
  - Cutout/arrester combo units save new install time

• Weight
  - Freight savings
  - Easier warehouse handling

• Safety
  - Ergonomics – low extended weight when installing
  - No potential sharp edges
3. Maintenance & Operations Advantages

a. Strength of fiberglass core over repeated interruptions and closures

b. Safety
   • No sharp edges due to damage (hail/ice)
   • No possibility of cracking or shrapnel dispersion under catastrophic events

c. Lifecycle & replacement
   • Longer lifecycles in polluted environments
   • No possibility of cracking due to thermal cycling
   • Reduced vandalism threat
   • Easier & cheaper disposal due to lighter weight
IV. MPS Polymer Cutouts
1. Design Advantages

a. MPS is an experienced leader in insulator design
   • 25+ Years and 29 million years of installed service life
   • Designs up to 500kV
   • All environments
   • This experience is designed into our cutouts

b. Advantages of Silicone vs. EPDM
   • Superior flashover performance
   • “Recovery” of hydrophobic properties
   • Superior UV & aging performance
   • Chemically inert – unaffected by pollutants

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[Graph showing electric stress vs. ESDD for Silicone hydrophobic, EPDM, and glass]

[Image of an insulator cutout]
1. Design Advantages cont.

c. Core
- Boron-free/corrosion resistant E-glass core
- High-strength to withstand dynamic loads during interruption & fuse replacement
- 3-point bend sampling tests

d. Alternating Shed Pattern
- Meets IEC 60815-1, 3 for polymer selection & dimensioning in polluted conditions
  - $s/p$ well above major competitors
  - Sufficient $C$ (distance between sheds)
  - Lower $l/d$ (leakage distance vs. clearance) than major competitors
  - Lower $l/A$ (leakage over arching distance) value
- Superior pollution performance (including ice)
1. Design Advantages cont.

e. Fittings
   • Crimped on fittings
     - Prevents rotation and alignment issues
     - Provides mechanical barrier against moisture ingress
   • Over-molded rubber design provides additional barrier against moisture ingress

f. Hardware
   • Thicker sleet-shield prevents deformation and upper contact pressure issues
   • Thicker top contacts prevent deformation after interruption or mishandling
   • “Floating” top contact design provides sufficient pressure should a non-MPS fuse holder be installed
   • Dimpled top contact prevents over-closures
   • Gentle top contact angle allows for easier closing
   • Eyebolts & parallel groove clamp connector options
2. Service Advantages

a. Domestic Factory
   • Polymer cutout assembly in York SC
   • Domestic stocking of components
   • Short lead times & disaster recovery

b. Storm Capabilities
   • Cross-trained operators allow capacity-flexing in emergencies
   • Capabilities for 3 shifts 7 days a week
   • York location is out of typical disaster areas, yet in 1-2 days proximity to major shipping lanes & destinations
References