

2015 INMR World Congress

Insulators, Arresters, Bushings, Cable
Accessories

Munich, Germany
19-21 October 2015

Volume 1 of 2

ISBN: 978-1-5108-1795-1

Printed from e-media with permission by:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571



Some format issues inherent in the e-media version may also appear in this print version.

Copyright© (2015) by Insulator News & Market Report (INMR)
All rights reserved.

Printed by Curran Associates, Inc. (2016)

For permission requests, please contact Insulator News & Market Report (INMR)
at the address below.

INMR
P.O. Box 95
Westmount (Montreal), Quebec
Canada H3Z 2T1

Phone: (514) 939-9540
Fax: (514) 939-6151

info@inmr.com

Additional copies of this publication are available from:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571 USA
Phone: 845-758-0400
Fax: 845-758-2633
Email: curran@proceedings.com
Web: www.proceedings.com

TABLE OF CONTENTS

VOLUME 1

Adaption of Cable Accessories for Onshore & Offshore Substation	1
<i>Matthias Freilinger</i>	
Advances in Surge Arrester Monitoring Technology	9
<i>Philipp Raschke</i>	
Advances in Remote Measurements of Pollution for Insulator Selection	21
<i>William Chisholm</i>	
Advances in Testing Polymer Insulators at Transmission Voltages	37
<i>Jeff Butler</i>	
Aesthetic Design of Power Lines & Pylons, Applications in France & Italy	45
<i>Hugh Dutton</i>	
Ageing Performance of Line Insulators Under Positive & Negative DC Excitation in a Severe Marine Environment	53
<i>Beulah Sepo Limbo Makuza</i>	
Analysis of Major Changes to Surge Arrester Standard IEC 60099-4	77
<i>Steve Brewer</i>	
A New Design Approach for Reliable EHV Paperless Dry Type Bushings	85
<i>Eric Euvrard</i>	
Arrester 2050	97
<i>Jonathan Woodworth</i>	
Canadian Experience with Aerial Patrols Utilizing Gimbal Systems to Scan Lines with IR & UV Equipment	104
<i>Derrick Brydges</i>	
Challenges and Opportunities to Make Overhead Lines More Visually Appealing to the Public	117
<i>Erik Bystrup</i>	
Classifying Pollution Severity for HV DC & UHV DC in China	129
<i>Su Zhiyi</i>	
Compact SF6 GIS & Dead Tank Breaker Bushings: Options and Limits	145
<i>Rainer Röder</i>	
Composite Insulated Instrument Transformers for AC and DC Applications	154
<i>Erik Sperling</i>	
Considerations in Developing High Energy ZnO MOV Blocks	163
<i>Ramón Puyané</i>	
Considerations in the Application of UAVs for Corona Inspection of Insulators	179
<i>Arye Ben Kalifa</i>	
Current Discrimination in ZnO Surge Arresters for Circuit Parameters & Condition Monitoring	188
<i>Manu Haddad</i>	
Design & Testing of Polymeric Insulators to Verify Pollution Performance Under DC Voltage	194
<i>Alberto Pignini</i>	
Design of the Insulator Strings for 600 kV DC Lines in the Harsh Environment of Saudi Arabia	206
<i>Ahmed Al-Mubarak</i>	
Design Principles for External Insulation at UHV DC Converter Stations up to 1100 kV	219
<i>Dong Wu</i>	
Development of Joints & Terminations for HVDC Extruded Cables	228
<i>Dario Quaggia</i>	
Development of Extremely High Current Rating Bushings for UHV & HVDC Ultra High Power Lines	235
<i>Giovanni Testin</i>	
Diagnostic Experience on HV Bushings Retired from Service	248
<i>Manuel Guzman</i>	
Diagnostic Measurement & Monitoring of High Voltage Bushings	259
<i>Michael Krüger</i>	
Diamond-Shaped Composite Insulator Array for New Transmission Lines in the UK	273
<i>Michael Fairhurst</i>	
Distinctions of EasyQuench Line Arresters Versus Conventional Metal-Oxide Arresters	291
<i>Alexander Nefedov</i>	
Effect of Termination Inclination Angle on Insulation Strength	301
<i>Rabah Boudissa</i>	

Electrolytic Corrosion of Hardware of Porcelain & Glass Suspension Insulators on UHV DC Lines	311
<i>Liming Wang</i>	
Emergency Kits for MV Distribution Network	319
<i>Vitor Miguel Ribeiro</i>	
Empirical Determination of the Remaining Lifetime through Artificial Ageing of Power System Components - Example PILC	325
<i>Christian Weindl</i>	
Evaluating the Reliability of Bushings	331
<i>Bernhard Heil</i>	
Evaluation of Flashover Voltage Properties of Snow Accreted Insulators on Transmission Lines	347
<i>Manabu Sakata</i>	
Evaluation of MO Resistors in Respect to Energy Handling Capabilities	360
<i>Volker Hinrichsen</i>	
Experience at Elia, the Belgian TSO: Designing, Testing, Building & Maintaining Compact Towers with Insulated Cross-arms	373
<i>Jean-Francois Goffinet</i>	
Overview of External Insulation Monitoring in Combined Harsh Desert, Marine & Industrial Environments	383
<i>Raouf Znaidi</i>	
Experience in the Netherlands with Wintrack Aesthetic Transmission Tower Designs	433
<i>Peter Kolmeijer</i>	
Experience in Testing Metal-Oxide Surge Arresters on Bosnia and Herzegovina Transmission Network	446
<i>Igor Djokic</i>	
Experiences of Using Dielectric Frequency Response Techniques for Insulation Assessment of Bushings and Instrument Transformers	455
<i>Matz Ohlén</i>	
Experience with Application of TLAs on a 400 kV line in the Scottish Highlands	464
<i>Brian Wareing</i>	
Experience with Cap & Pin Insulators Covered by Silicone Rubber	478
<i>Tao Deng, Jun Zhou</i>	
Experience with Insulation in Desert & Coastal Environments	493
<i>Brian Wareing</i>	
Fiberglass Rods for Modern Composite Insulators	509
<i>Tony Baker</i>	
Field Experience and Reliability Tests for the New EasyDry Condenser Bushing	515
<i>Lukas Muggli</i>	
Full-Scale Testing of HVDC Energized Insulators for High Salt Contamination & High Ice Environment	532
<i>Kyle Tucker</i>	
Future Needs for Overhead Line Design to Optimize Aesthetics & Costs	547
<i>Alexander Braun</i>	
Going Global from Bavaria: Silicones for Transmission & Distribution	553
<i>Georg Simson</i>	
Growing Demand for Testing DC Cables & Accessories: Experience & Special New Requirements	556
<i>Heiko Jahn</i>	
Heat-Shrink Cable Accessories: A 40 Year Proven Technology for Applications in Harsh Environments	562
<i>Frank Drumm</i>	
High Voltage Diagnostic Measurements For Surge Arrester Condition Monitoring	572
<i>John Lauletta</i>	
High Voltage Insulator Testing Based on Electric Field Method	579
<i>Charles Jean</i>	
How Certified T&D Components Help to Improve Power Network Performance	586
<i>Bas Verhoeven</i>	
How to Design Insulation for Improved Performance in Severe Desert/Sea Service Areas	596
<i>Brian Wareing</i>	
How to Specify the Optimum Non-Gapped Line Arrester, NGLA	616
<i>Bengt Johnnerfelt</i>	
HVDC Insulators	628
<i>Jean-Marie George</i>	

Hybrid Insulators – Another Solution for Improved Performance	637
<i>Gustav Gödel</i>	
Impact of Rate of Expansion on Electric Field Stress in Stress Cones & Joint Bodies	649
<i>Thomas Klein</i>	

VOLUME 2

Importance of Corona Rings with Non-Ceramic Insulators: Experience on 400 kV Transmission Lines in Venezuela	662
<i>Cristian Gutierrez Aguirre</i>	
Improvement & Testing of Metal Oxide Arresters for DC Applications	671
<i>Bernd Kruska</i>	
Improvements in Medium Voltage MOV Blocks & Evaluation of Their Surge Withstand Capability	682
<i>Minoru Tsukazaki, Naoyuki Tsukamoto</i>	
Improving Performance of Porcelain Insulators Under Seismic Conditions	689
<i>Patrick Maloney</i>	
Incidence & Analysis of Failures of HVDC Bushings	695
<i>Su Zhiyi</i>	
Increasing Transformer Reliability by Proactive Management of the Bushing Fleet	708
<i>Thomas Schütte</i>	
Insulator Design for Desert Environments	725
<i>Alberto Pignini</i>	
Insulator Inspection	737
<i>A. J. (Tony) Carreira</i>	
Interaction of Vibration Dampers with Surge Arresters	747
<i>William Chisholm</i>	
KEPCO's Insulator Management and Planning	768
<i>Park Hyunmin</i>	
Key Note Address: Overhead Lines in the 21st Century: Technologies, Challenges & Solutions	780
<i>Konstantin Papailiou</i>	
Latest Development for HV Cable Accessories – Challenges and Trends	789
<i>Ruben Grund</i>	
Learning from Experience: Type Testing Cables and Accessories is Still Essential	798
<i>Ronald Gruntjes</i>	
Line Arresters – Life Insurance of the Grid	811
<i>Uli Bauch</i>	
Lightning & Its Effects on the Florida Power & Light Distribution System & Other Related Issues	816
<i>Larry Vogt</i>	
Looking to the Future of Cable & Accessory Design: From MV to EHV	826
<i>Klaus Dieter Haim</i>	
Mitigating Geomagnetic Induced Currents Using Surge Arresters	838
<i>Alberto Ramirez</i>	
Mitigating Transmission Line Arrester Lead Stresses	847
<i>Chris Engelbrecht</i>	
Monitoring Pollution Levels of Line & Substation Insulators	859
<i>Giovanni Pirovano</i>	
Multi-Chamber Arrester Field Test Experience in Asia High Lightning Density Area	868
<i>Jens R. Bothe</i>	
Novel Preparation Method of SnO₂ and ZnO Varistor Ceramic Powders	876
<i>Renaud Metz</i>	
New CIGRÉ Principles for DC Insulation Selection	885
<i>Chris Engelbrecht</i>	
New Concepts in Arrester Voltage Grading	897
<i>Jens Seifert</i>	
New Method for Inspection & Detection of Composite Insulator Designs Susceptible to Brittle Fracture	902
<i>Bálint Németh</i>	
New Technologies of Moulding Machines for Composite Insulator, Arrester, Cable Accessories & Hollow Insulator	915
<i>Shihai Wang</i>	

New Test Criteria for Evaluating the Quality of Glass Insulators	921
<i>Kjell Halsan</i>	
On-Line Monitoring of Surge Arresters	935
<i>Steve Brewer</i>	
Operation of ZnO-Based Varistors in Overvoltage Protection: Principles, Quality Assurance & Recent Developments	947
<i>Daniel Fernández Hevia</i>	
Optimal Dimensioning of Corona/Grading Rings for Composite Insulators: Calculations & Verification	964
<i>Igor Gutman</i>	
Overview of World Markets for HV Insulators & Bushings 2015 to 2025	977
<i>Steve Aubertin</i>	
Polymeric Insulator Materials for HVDC: Important Properties, Test Methods & Challenges for Standardization	987
<i>Jens Seifert</i>	
Porcelain Insulators and Covered Conductors – A Problem of Dielectric Compatibility	999
<i>Eduardo Hilsdorf</i>	
Power Arc Testing on Insulator Sets	1012
<i>Robert Jech</i>	
Practical Development & Implementation of Aesthetic New Power Lines - Case Histories & Lessons Learned	1023
<i>Brian Endahl</i>	
Practical Experience in UHV DC Dielectric & Pollution Testing	1035
<i>Dan Windmar</i>	
Production of HV Articles of LSR & HTV Silicone Using High-Pressure Injection Moulding	1046
<i>Harald Schmid</i>	
Production Systems for LSR Insulators and Cable Accessories: Process Engineering by Objectives	1052
<i>Michel Gehrig</i>	
Quick Recovery Techniques of Surface Hydrophobicity for Contaminated HTV Silicone Rubber	1060
<i>Ruobing Zhang</i>	
Recoating and Repairing Techniques for RTV Coated Insulators and Bushings	1067
<i>Zhidong Jia</i>	
Real World Experience with Line Arresters	1077
<i>Marian Florea</i>	
Research on Material, Mechanical & Electrical Properties of Rigid Epoxy Composite Insulators	1090
<i>Chenlong Zhao</i>	
Review of Possible Upcoming Changes to IEC 60137 Dealing with Bushings for AC Voltages More than 1000V	1096
<i>Lars Jonsson</i>	
Role of Innovation in Today's Generation of Insulators & Surge Arresters & In-Service Monitoring Technologies	1105
<i>Frank Lopez</i>	
RTV Silicone Coating of Polymeric Insulator Housings with Surface Degradation	1113
<i>Vaclav Sklenicka</i>	
Silicone Coating on Toughened Glass Insulators: Review of Laboratory & Field Performance	1126
<i>Fabien Virlogeux, Jean-Marie George</i>	
Silicone Elastomers for Outdoor DC Applications: Experience & Requirements	1137
<i>Jens Lambrecht</i>	
SnO₂ & ZnO Based Varistors: Comparative Properties & Degradation Behavior	1141
<i>José A. Varela</i>	
Solutions for Line Compaction Using Composite Insulators: Review of Current Situation & Future Outlook	1153
<i>Frank Schmuck</i>	
State of the "Corona Camera" Industry - Past, Present and Future	1161
<i>Riaan Rossouw</i>	
Station Post Insulators (SPI), An Emerging Application for Composite Hollow Core Insulators	1170
<i>Peter Siall</i>	
Successful Development & Implementation of the Eagle Transmission Line Pylon	1176
<i>Sebastian Dollerup</i>	
Thermal Stability of HV & UHV Arresters with Reduced Grading Systems	1182
<i>Volker Hinrichsen</i>	

Technology Innovations for Crimping of Composite Insulators	1195
<i>Carsten Baumgartner</i>	
The Development and Operation of Novel Built-in Insulation Monitoring Functions in the Management of HV Bushings	1206
<i>Eric Euvrard</i>	
The Numerical Measurement of Corona Discharges on High Voltage Electrical Equipment, Using a Camera	1217
<i>Roel Stolper</i>	
Time-Effective Rapid Test Procedures for Pollution Testing of Different Types of Insulators	1228
<i>Igor Gutman</i>	
Towards a Sustainable Modernization of the Electricity Grid	1241
<i>Antina Sander</i>	
Trends in Energy Varsitors	1249
<i>Tony Sun</i>	
Typical Approach & Practical Case Studies for AC To DC Conversion Projects	1256
<i>Andreas Dornfalk</i>	
Unique Features of Metal Encapsulated SF⁶-Insulated Surge Arresters	1266
<i>Danijel Udovic</i>	
Use of Wireless Leakage Current Monitors to Improve Overhead Network Performance	1271
<i>Chris Engelbrecht</i>	
UV-Initiated Polysilylation & Resulting Production Technology	1283
<i>Georg Simson</i>	
Voltage Distribution along Surge Arresters Under Influence of Temperature	1288
<i>Christoph Hippler, Karsten Laue</i>	
Wildlife Induced Outages and Protection of Overhead Lines & Substations	1304
<i>Don Barrett</i>	
Author Index	