

1. Record Nr.	UNINA9910544862103321
Autore	Farzaneh M (Masoud)
Titolo	Techniques for protecting overhead lines in winter conditions dimensioning, icephobic surfaces, de-icing strategies / / M. Farzaneh, William Alexander Chisholm
Pubbl/distr/stampa	Cham, Switzerland : , : Springer, , [2022] ©2022
ISBN	3-030-87455-9
Descrizione fisica	1 online resource (400 pages)
Collana	CIGRE green books
Disciplina	363.189
Soggetti	Overhead electric lines - Environmental aspects Ice prevention and control
Lingua di pubblicazione	Inglese
Formato	Materiale a stampa
Livello bibliografico	Monografia
Nota di bibliografia	Includes bibliographical references and index.
Nota di contenuto	Intro -- Foreword -- Preface -- Acknowledgments -- Message from the Secretary General -- Contents -- About the Authors -- 1 Introduction -- 1.1 Mechanisms of Ice Adhesion -- 1.2 Processes of Natural Ice and Snow Shedding -- 1.3 Operative and Design Systems for Anti-icing (AI) and De-Icing (DI) -- 1.3.1 Passive Methods -- 1.3.2 Active Coating Methods -- 1.3.3 Mechanical Methods -- 1.3.4 Thermal Methods -- 1.3.5 New Materials -- 1.3.6 New Weather Monitoring Systems -- 1.4 Types of Atmospheric Ice Accretion and Their Characteristics -- 1.4.1 Glaze -- 1.4.2 Hard and Soft Rime -- 1.4.3 Dry and Wet Snow -- 1.4.4 Hoar Frost -- 1.5 Overview of Atmospheric Icing and Its Effects on Overhead Power Networks -- 1.5.1 Direct Impact of Icing Events in Canada (1988) -- 1.5.2 Direct Impact of Icing Events in UK (1990) -- 1.5.3 Direct Impact of Icing Events in South Africa -- 1.5.3.1 Icing Event, KwaZulu Natal, 2001 -- 1.5.3.2 Cross-arm Failure -- 1.5.3.3 Icing Event, KwaZulu Natal, 2012 -- 1.5.3.4 Snow/Ice Events, Southern Cape: 2002-2009 -- 1.5.4 Direct Impact of Icing Events in Iceland -- 1.5.4.1 Historical Experience, 1960-2012 -- 1.5.4.2 Wet Snow Event, 2012 -- 1.5.4.3 Icing Experiences, 2014-2019 -- 1.5.5 Direct Impact of Icing Events in Sweden (1999) -- 1.5.6 Direct Impact of Wet Snow Event in Japan (2005) -- 1.5.7 Direct Impact of Icing Event in China (2008) -- 1.5.8 Direct Impact of Icing Event in

Catalonia, Spain (2010) -- 1.5.9 Direct Impact of Icing Events in Norway (1961-2014) -- 1.5.9.1 Heavy Ice Accretion, 1961 -- 1.5.9.2 Polluted Rime Ice Accretion, 1980s and 1990s -- 1.5.9.3 In-cloud Ice Accretion, 2014 -- 1.5.10 Direct Impact of Icing Events in Italy (2015-2017) -- 1.5.10.1 Direct Impact of Icing Events in Slovenia -- 1.5.10.2 Indirect Impacts of Winter Conditions -- 1.6 Global Climatology of Relevant Winter Weather Parameters.

1.6.1 Ambient Temperature and Dew Point Under Icing Conditions -- 1.6.2 Precipitation Icing -- 1.6.3 In-cloud Icing -- 1.6.4 Hoar Frost -- 1.6.5 Consecutive Dry Days in Winter -- 1.6.6 Synoptic and Exceptional Wind Speeds -- 1.6.7 Persistence of Ice Accretion -- 1.6.8 Occurrence of Multiple (Ice-on-Ice) Events from Consecutive Storms -- 1.6.9 Atmospheric Corrosion Measures -- 1.6.9.1 Corrosion Process -- 1.6.9.2 Atmospheric Corrosion -- Rural Atmosphere -- Urban Atmosphere -- Industrial Atmosphere -- Marine Atmosphere -- 1.6.9.3 Classification: Atmosphere Corrosivity -- 1.6.9.4 Classification: Time of Wetness -- 1.6.9.5 Classification: State of Corrosion of Overhead Line Components -- Grade 0 -- Grade 1 -- Grade 2 -- Grade 3 -- Defect Condition -- 1.6.9.6 Procedures to Prevent or Mitigate Corrosion of the Components of Overhead Lines -- 1.6.10 Man-Made and Natural Pollution as PM_{2.5} Aerosol Density -- 1.6.11 Pollution Deposition Velocity (relating PM_{2.5} to Rate of Increase of SDD) -- 1.6.12 Annual and Winter Season Lightning Parameters -- 1.7 Anticipated Effects of Climate Change on Winter Weather -- 1.8 Concluding Remarks -- 2 Dimensioning for Winter Conditions in Overhead Line Design -- 2.1 Tower Head Clearances for Galloping -- 2.2 Tower Head Clearances for Passive Mitigation of Ice Accretion and Sleet Jump -- 2.3 Midspan Clearances for Passive Mitigation of Ice Accretion and Sleet Jump -- 2.4 Conductor Sag and Clearance to Ground -- 2.5 Electrical Clearances for Insulators -- 2.5.1 Stress Per Metre of Dry Arc Distance on Vertical Suspension Insulators -- 2.5.2 Stress Per Metre of Leakage Distance -- 2.5.3 Stress Per Metre of Live-Line Tool Length -- 2.6 Concluding Remarks -- 3 Systems for Monitoring and Predicting Ice Accretion and Shedding -- 3.1 Meteorological Weather Forecasting Models -- 3.2 Measurements of Conductor Mechanical State.

3.2.1 Dedicated Test Lines -- 3.2.2 Lines Equipped with Dynamic Line Monitoring -- 3.2.3 Dynamics of Ice Persistence and Release -- 3.2.4 Conductor Slip Loads -- 3.2.4.1 Controlled Slippage Suspension Clamps -- 3.2.4.2 Spacer Clamp Performance -- 3.2.4.3 Tension (Dead-End) Clamp Performance -- 3.3 Measurements of Ice Accretion -- 3.3.1 Need for Field Data -- 3.3.2 Direct Measurements Using Meteorological Data Sources -- 3.3.3 Preparations by Utilities and Field Staff -- 3.3.4 Observations on Non-instrumented Lines -- 3.3.5 Weather and Line Location Data -- 3.3.6 Physical Dimensions -- 3.3.7 Weight of Ice on Conductors -- 3.3.8 Density -- 3.3.9 Moulds or 3D Digital Models for Cross Section -- 3.3.10 Number of Observations on Conductors -- 3.3.11 Observations on Insulators -- 3.3.11.1 Consolidation of Data -- 3.4 Measurements of Audible Noise -- 3.4.1 Corona Discharge and Dry Band Arcing -- 3.4.2 Partial Discharge Noise Emitted by Insulators -- 3.4.3 Audible Noise from Conductors in Icing Conditions -- 3.5 Attenuation of Power Line Carrier Signals -- 3.6 Results from Typical Overhead Line Winter Monitoring Programs -- 3.6.1 Results from China -- 3.6.2 Results from Iceland -- 3.6.3 Results from Italy -- 3.6.4 Results from Norway -- 3.6.4.1 Results from Ålvikfjellet Measuring Station -- 3.6.4.2 Results from Hardingsnuten Measuring Station -- 3.6.4.3 Results from Stølsheimen Measuring Station -- 3.6.4.4 Description of Other Measurement Stations --

3.6.4.5 Summary of Norwegian Experience with Outdoor Ice-Monitoring Sites -- 3.6.5 Results from United Kingdom -- 3.7 Concluding Remarks
-- 4 Systems for Preventing Icing on Existing Overhead Power Line Conductors and Ground Wires -- 4.1 Mechanical Properties of Ice --
4.1.1 Liquid Water Content (LWC) -- 4.1.2 Ice Type and Density --
4.1.3 Microhomogeneity -- 4.1.4 Shape and Density of the Accreted Ice Sleeve.
4.1.5 Temperature -- 4.2 General Heat Balance -- 4.2.1 Currents Needed for Anti-icing effects -- 4.2.2 Steady-State Heat Balance Including Freezing Precipitation -- 4.3 Mechanisms of Ice Adhesion --
4.3.1 Surface Tension -- 4.3.2 Intermolecular Forces -- 4.3.2.1 Electrostatic Forces -- 4.3.2.2 Surface States -- 4.3.2.3 Acid-Base Hydrogen Bonding Forces -- 4.3.2.4 Lifshitz-van der Waals Forces --
4.3.2.5 Mechanical Interlocking -- 4.3.2.6 Quasi-Liquid Layers --
4.3.2.7 Capillary Force -- 4.3.3 Influence of Surface Roughness on Ice Adhesion -- 4.3.4 Influence of the Quasi-Liquid Layer -- 4.3.5 Heterogeneous Surface -- 4.3.6 Influence of Ice Structure on Its Adhesion -- 4.3.7 Concluding Remarks -- 4.4 Principles of Hydrophobicity and Icophobicity -- 4.4.1 Characterization of Wettability/Hydrophobicity -- 4.4.2 Process of Wetting and Hydrophobicity -- 4.4.3 Superhydrophobicity Links to Icophobicity --
4.4.4 Principles of Icophobicity -- 4.4.4.1 Surface Characteristics Relevant to Icophobicity -- Surface Roughness -- Surface Energy -- Superhydrophobicity -- Thermal Conductivity -- Time of Contact -- Dielectric Constant -- Surface Heterogeneity -- 4.5 Anti-icing Coating Concepts for Power Network Equipment -- 4.5.1 Concept 1-Decrease Mechanical Friction by Reducing Surface Roughness -- 4.5.2 Concept 2-Decrease Mechanical Interlocking by Reducing Contact Ice/Surface Area -- 4.5.3 Concept 3-Delay Freezing by Reducing Contact Area and Thermal Conductivity -- 4.5.4 Concept 4-Reduce Adhesion Forces by Reducing Surface Energy -- 4.5.5 Concept 5-Reduce Ice Adhesion and Facilitate Its Shedding by Applying SLIPS Coatings -- 4.5.6 Concept 6-Use of Freezing Point Depressant Fluids -- 4.5.7 Concept 7-Use of Combined Passive and Active Coatings -- 4.5.8 Concept 8-Active Ice Electrolysis system.
4.5.9 Concept 9-Induce Ice Internal Cracking by Using Inhomogeneous Surfaces -- 4.5.10 Concept 10-Active Materials -- 4.5.11 Concluding Remarks -- 5 Systems for De-Icing Overhead Power Line Conductors and Ground Wires -- 5.1 Mechanisms of Ice Shedding -- 5.1.1 Melting -- 5.1.2 Sublimation -- 5.1.3 Mechanical Ice Breaking -- 5.2 Mechanisms of Snow Shedding -- 5.2.1 Adhesion Forces in Snow Accretion -- 5.2.1.1 Adhesion Forces for Dry Snow -- 5.2.1.2 Adhesion Forces for Wet Snow -- 5.2.2 Cohesive Limit -- 5.2.3 Factors Influencing Liquid Water Content (LWC) -- 5.3 Mechanical Methods for De-Icing -- 5.3.1 Passive Methods -- 5.3.2 Scraping Methods -- 5.3.3 Shock Wave Methods -- 5.3.3.1 Mechanical Shocks with Live-Line Tool or Rope from Ground -- 5.3.3.2 Mechanical Shocks with Live-Line Tool or Rope from Helicopter -- 5.3.3.3 Electromechanical Shocks -- 5.3.4 Vibrating Devices -- 5.3.4.1 Vertical Oscillation at Span Resonant Frequency -- 5.3.4.2 Torsional Oscillation at Span Resonant Frequency -- 5.4 Thermal Methods for De-Icing -- 5.4.1 Joule-Effect Methods: Historical Experiences -- 5.4.1.1 Joule De-Icing, New England Electric, 1920 -- 5.4.1.2 Joule De-Icing, New England Electric, 1939 -- 5.4.1.3 Joule De-Icing, American Gas and Electric, 1954 -- 5.4.1.4 Joule De-Icing, Manitoba Hydro, 1970s -- 5.4.1.5 Joule De-Icing, Present Day -- 5.4.2 Equations Governing De-Icing with Joule Effect -- 5.4.3 Ice Melting Power Requirements for Conductors -- 5.4.4 De-icing Conductors Using Skin Effect -- 5.4.4.1 Dielectric Coating and 60 kHz

- 5.4.4.2 Electrothermal Pulse -- 5.4.4.3 Magnetic Melting Methods
 - 5.4.5 De-Icing Ground Wires using Heat Tracing or Ice Electrolysis
 - 5.4.6 Steam De-Icing -- 5.4.7 Radio frequency and Radiant Energy De-Icing
 - 5.5 Concluding Remarks -- 6 Protective Coatings for Overhead Lines in Winter Conditions.
 - 6.1 Anti-corrosion Coatings and Materials.
-