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电力系统运行与规划

架空线路覆冰闪络跳闸特性分析与风险建模

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摘要：

极端冰灾天气下线路覆冰闪络跳闸是激发大电网脆弱性、导致大面积停电的重要因素。覆冰闪络跳闸等现象的风险评估是建立冰灾防御体系的基础。基于电网层面，进行了冰灾天气下线路覆冰闪络跳闸的风险状态识别与风险建模。根据覆冰闪络跳闸特性分析，界定了输电网绝缘系统的脆弱点，即覆冰期绝缘系统冰凌桥接、融冰期冰凌断流等临界点。进一步建立了覆冰闪络状态的划分原则与风险等级，并对预测冰况进行了模糊模式识别和风险评级，为运行人员提供了动态风险信息。针对数据的小样本、多输入等特点，采用统计学习理论结构风险最小化方法，构建了最小二乘支持向量机(least squares support vector machine，LSSVM)冰闪跳闸风险评估模型，依据贝叶斯(Bayesian)证据推理优化模型参数。通过与误差反向传播人工神经网络(artificial neural network with error back propagation，BP-ANN)算法对比，验证了该模型的有效性。最后通过脆弱性指标分析了网架结构破坏的严重性与电网绝缘系统的脆弱性。

关键词： 极端冰灾天气 覆冰闪络跳闸 模糊状态识别 风险评级 小样本数据建模 脆弱性指标

Overhead Transmission Line Icing Flashover Trip Characteristic Analysis and Risk Model

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Abstract:

Icing flashover trip is the key factor in stimulating vulnerability of power grids and leading to large-scale blackout. Ice flashover trip characteristic analysis and risk modeling were carried out based on grid level in the study. According to icing flashover characteristic analysis, the critical values of ice bridged and off-bridged of insulation system were identified. Furthermore, state division principle and risk rating method were proposed. State recognition was conducted by fuzzy theory. Considering the small sample and multi-input characteristics of the data, structural risk minimization principle was adopted, and a least squares support vector machines (LSSVM) risk model was built. Model parameters were optimized by Bayesian evidence reasoning. The comparative study of the proposed model with artificial neural network with error back propagation (BP-ANN) was proved that Bayesian-LSSVM had strong generalization ability. Finally, a set of vulnerability indices was used to analyze ice flashover trip vulnerability characteristics of the power grid.

Keywords: extreme ice disaster weather icing flashover trip fuzzy state recognition risk rating small sample modeling vulnerability index

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