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變電所故障指示器之四國製維修報告

Maintenance Report of Shikoku-Made Fault Indicators in Substations

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摘 要

近年來老舊 D/S 23kV CGIS 故障指示器陸續出現損壞情形，而更換一台新品要價約四萬元，成本很高且數量龐大。因此本所研議自行維修故障指示器，以達到節省成本及技術扎根等目的。以北柳 D/S 四國製 12 台故障指示器故障為例，自行維修材料成本僅需 600 元，全部維修可省下 48 萬元。本文將故障指示器電路模塊化並依序分析，得知損壞問題點出在電源供應器上，接著再計算各元件所產生的最大功率，之後反推最大電流，得到所需的電源供應器規格，最後將符合規格的電源供應器替換舊有電源供應器完成維修。以上方法可套用在不同型號的故障指示器上，維修效益遠遠不只 48 萬，因此希望藉由此文章讓相關單位能掌握維修故障指示器的技術，除提升技術以外，並為公司節省更多維護成本。

Abstract

In recent years, fault indicators used in aging 23kV CGIS substations (D/S) have increasingly experienced failures. The replacement cost of a new unit is approximately NTD 40,000, resulting in significant expenses due to the large number of installed devices. To reduce costs and strengthen in-house technical capability, this study investigates the feasibility of in-house repair of faulty indicators.

A case study involving twelve failed Shikoku-made fault indicators at Beiliu D/S is presented. The repair cost was reduced to approximately NTD 600 per unit, achieving a total cost saving of about NTD 480,000. The fault indicator circuit was decomposed into functional modules and analyzed step-by-step, revealing that the primary failure occurred in the power supply module. Subsequently, the maximum power consumption of each component was evaluated, and the corresponding maximum current was derived to determine the required specifications of the replacement power supply unit. A new power supply meeting these specifications was then installed, successfully restoring device functionality.

The proposed methodology is applicable to different indicator models. The potential economic benefit extends beyond the case presented in this study. The findings demonstrate that the proposed approach can effectively reduce maintenance costs while enhancing technical capability within relevant operating units.

關鍵詞(Key Words)：故障指示器(Fault Indicator)、電源供應器(Power Supply)、維修(Maintenance)。

台電潛盾洞道施工測量案例探討

A Case Study on Surveying Operations in Taipower's Shield Tunnel Construction Projects

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摘要

台電特高壓纜線工程常需採用潛盾洞道等免開挖工法，以克服施工環境困難及降低對環境與交通影響。為準確依設計施工，避免造成侵入私地及洞道長度、真圓度與高程過大誤差，潛盾洞道測量作業扮演重要且關鍵角色。本文以實際台電潛盾洞道施工案例來探討潛盾掘進前、掘進中及貫通後各施工階段測量作業方式與監造重點，期提供相關實務經驗予其他計畫參考。

Abstract

In Taipower's extra-high voltage (EHV) cable installation projects, trenchless construction methods such as shield tunneling are frequently employed to overcome challenging site conditions and to reduce environmental and traffic impacts. Accurate surveying is essential to ensure that construction is executed in accordance with design specifications and to avoid issues such as encroachment on private property and excessive deviations in tunnel length, circularity, and elevation.

This paper presents a case study of a Taipower shield tunneling project, focusing on surveying operations and construction supervision requirements at various construction stages, including pre-tunneling preparation, in-tunnel excavation, and post-breakthrough verification. The findings aim to provide practical experience and references for future engineering projects.

關鍵詞 (Key Words)： 潛盾洞道 (Shield Tunnel)、免開挖工法 (Trenchless Construction Methods)、測量作業 (Surveying Operations)。

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暫態特徵之非侵入式家電負載解析平台開發與商業化試驗

Development of a Non-Intrusive Appliance Load Monitoring Platform based on Transient Features for Commercial Application

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摘要

全球電業自由化推動智慧電表大數據應用，非侵入式家電負載解析(NIALM)成為關鍵技術，涵蓋資料收集、特徵萃取、訊號解析與家電運轉狀態識別，可應用於自主節電、負載移轉及居家異常偵測等服務。本計畫分析歐美日代表性 NIALM 發展與商業模式，並整理國際最新技術與應用框架。

為此，本計畫開發具邊緣運算功能之 NIALM 感測器，完成 10 戶家庭及實驗展示場域安裝，建立暫態特徵資料集，並在六類家電辨識上達到 80%以上精確度。主要挑戰為真實場域下家電特徵稀缺性，未來台灣推動 NIALM 商業服務，亟需建置本地家電特徵資料庫以促進異業結盟與商業化發展。

Abstract

The liberalization of global electricity markets has accelerated the application of smart meter big data, positioning Non-Intrusive Appliance Load Monitoring (NIALM) as a pivotal technology. NIALM encompasses data collection, feature extraction, signal decomposition, and appliance state recognition, facilitating services such as autonomous energy conservation, load shifting, and residential anomaly detection. This study reviews representative NIALM developments and business models in the EU, Japan, and the US, while synthesizing the latest international technical and application frameworks.

To this end, this project developed a NIALM sensor equipped with edge computing capabilities. The system was deployed across 10 households and experimental demonstration sites to establish a comprehensive transient feature dataset, achieving an identification accuracy of over 80% for six categories of appliances. A primary challenge identified is the scarcity of appliance features in real-world environments. Consequently, establishing a localized appliance feature database is essential for Taiwan to foster cross-industry alliances and advance the commercialization of NIALM services.

關鍵詞(Key Words)：非侵入式家電負載解析(Non-Intrusive Appliance Load Monitoring, NIALM)、暫態特徵(Transient Features)、多事件辨識(Multi-Event Identification)。

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輸電鐵塔塔基監測應用衛星通訊之可行性研究

Feasibility Study on the Application of Low Earth Orbit (LEO) Satellite Communication for Transmission Tower Foundation Monitoring

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摘要

輸電鐵塔多位於山坡地或偏遠地區，受氣候變遷、極端降雨、地質變動影響，塔基及邊坡穩定性成為電力安全的重要隱憂。傳統巡檢受地形阻隔與災害影響，難以即時進行，而現有自動化監測系統多依賴行動網路，在偏遠地區或極端天候下易中斷資料回傳。本研究探討低軌道衛星通訊(LEO)於塔基監測的應用可行性，並透過實地測試比較其與行動網路、區域網路之效能與成本差異。結果顯示，衛星通訊在偏遠與盲區環境下的資料回傳率可達 99% 以上，且在颱風等災害期間保持穩定，顯著提升防災即時性與可靠性。雖然單站建置與維護成本較高，但在高風險區域的防災效益具經濟合理性。本研究最後提出分級部署策略與建議，供相關單位規劃參考。

Abstract

Transmission towers are predominantly situated on hillsides or in remote areas, where climate change, extreme precipitation, and geological shifts pose significant threats to the stability of tower foundations and adjacent slopes, threatening power system safety. While traditional manual inspection methods are often hindered by challenging terrain and environmental hazards, existing automated monitoring systems typically rely on terrestrial mobile networks, which are prone to signal interruptions in remote regions or under extreme weather conditions. This study investigates the feasibility of applying Low Earth Orbit (LEO) satellite communications for tower foundation monitoring and conducts field tests to evaluate its performance and cost-effectiveness relative to mobile and local area networks. The results demonstrate that satellite communication achieves a data transmission reliability exceeding 99% in remote and signal-blind zones, maintaining stable connectivity even during typhoons. Such performance significantly enhances the real-time capabilities and reliability of disaster prevention efforts. Although individual site deployment and maintenance costs are higher, the disaster mitigation benefits in high-risk areas provide clear economic justification. Finally, this study proposes a tiered deployment strategy and practical recommendations to guide future infrastructure planning by relevant authorities.

關鍵詞(Key Words)：輸電鐵塔 (Transmission Tower)、物聯網監測系統 (Internet of Things Monitoring System)、低軌衛星通訊 (Low Earth Orbit Satellite Communication)、可行性評估 (Feasibility Assessment)。

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智慧電表材規修訂之可行性研究

Feasibility Study on Revising Material Specifications for Smart Meters

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摘要

本研究旨在探討智慧電表材規修訂之可行性。近年來，因台灣氣候逐年升溫，加上再生能源大量併網所引發之突波事件增加，使夏季期間智慧電表損壞案例呈現上升趨勢；同時，電磁干擾與 RF 通訊干擾亦會造成智慧電表異常。鑑此本研究評估透過修訂材規以降低智慧電表損壞風險。本研究首先針對智慧電表之耐候性試驗、突波試驗及電磁干擾試驗等國內外相關標準進行綜合性分析，並同步拜訪各電表廠商與試驗單位，蒐集智慧電表於試驗過程與實際案場中所發生之故障案例，以全面掌握現行智慧電表面臨之問題與技術需求。最後，綜整標準分析、實務訪查與故障案例資料後，對台電智慧電表材規提出修訂建議，以作為後續標準制定與優化之重要參考依據。

Abstract

This study aims to evaluate the feasibility of revising the material specifications for smart meters. In recent years, rising ambient temperatures in Taiwan, coupled with an increasing number of surge events triggered by large-scale integration of renewable energy, have contributed to a growing incidence of smart meter failures during the summer season. Additionally, electromagnetic interference (EMI) and radio frequency (RF) communication interference have also been identified as contributing factors to abnormal meter operation.

In this context, the feasibility of modifying material specifications to reduce smart meter failures is examined. A comprehensive review of domestic and international standards related to weather resistance, surge, and EMI testing for smart meters was conducted. In parallel, field visits were conducted to meter manufacturers and testing organizations to collect failure cases from both laboratory testing and real-world deployment, thereby enabling a systematic understanding of current technical challenges.

Finally, by integrating findings from standard reviews, industry interviews, and failure case analyses, this study proposes recommendations for revising Taipower's smart meter material specifications. These recommendations are intended to serve as a reference for future standard development and system optimization.

關鍵詞(Key Words)：智慧電表(Smart Meter)、材規(Material Specifications)、突波(Surge)、電磁干擾(Electromagnetic Interference, EMI)。

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再生能源售電業售電業務精進之研究—以契約風險為中心

Enhancing the Operations of Renewable Energy Retailers : A Contractual Risk Perspective

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摘 要

本文旨在探討如何精進再生能源售電業務，特別是再生能源發電量會受天氣因子等非人力可控因素影響，於綠電交易時會因為實際發電量與預測電量有所差異產生之平衡風險(Balancing Risk)、用戶用電需求時段與發電場發電時段無法契合而產生差異之型態風險(Shape/Profile Risk)，及因再生能源不確定性致無法提供約定供電量或產生餘電(Volume Risk)等三大特殊風險因素而衍生損失。

本文分析國際上購售電契約實例，探討三大契約風險於我國之應用情形。如日本、英國、美國加州等於電力市場自由化下，再生能源經由電證分離與契約風險分配，對上述風險均有合理處理方式。然我國在綠電先行與電證合一下，會於一般轉供機制形成特殊風險樣態：平衡風險主要由台電承擔；型態風險使售電業須精準媒合多元發電案場與用戶；數量風險則具體化為餘電難題，此成為再生能源售電業之主要營運挑戰。

Abstract

This study investigates strategies to enhance the operations of Renewable Energy Retailers (RERs), with a focus on contractual risks arising from renewable energy trading. Due to the inherent variability of renewable energy generation, which is influenced by uncontrollable factors such as weather conditions, three major types of risks are identified: (1) balancing risk, which refers to the discrepancy between forecasted and actual electricity generation; (2) shape/profile risk, arising from the mismatch between generation patterns and end-user demand profiles; and (3) volume risk, which results from the uncertainty in renewable energy output that may lead to either under-delivery or surplus energy.

This study further analyzes international power purchase agreement (PPA) practices and examines how these risks are managed in liberalized electricity markets, including Japan, the United Kingdom, and California in the United States. In these markets, mechanisms such as renewable energy certificate (REC) unbundling and explicit contractual risk allocation have been widely adopted to mitigate such risks effectively. In contrast, Taiwan's renewable energy market, characterized by a Green Power First policy and a bundled T-REC system under the existing wheeling mechanism, presents distinct risk allocation structures. Specifically, balancing risk is largely borne by Taiwan Power Company (Taipower); shape risk requires retailers to precisely match diverse generation assets with customer demand; and volume risk manifests as surplus electricity, which has become a major operational challenge for renewable energy retailers in Taiwan.

關鍵詞(Key Words)：再生能源售電業(Renewable Energy Retailers, RERs)、再生能源購售電契約(Renewable Power Purchase Agreements)、平衡風險(Balancing Risk)、型態風險(Shape/Profile Risk)、數量風險(Volume Risk)。

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民國 114 年核一、二、三廠緊急應變計畫區檢討修正

Review and Revision of Emergency Planning Zones for Chinshan, Kuosheng, and Maanshan Nuclear Power Plants in 2025

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摘要

本評估報告依照「核子事故緊急應變法施行細則」第三條規定的評估準則，沿用民國 111 年緊急應變計畫區評估方法並更新氣象資料(民國 108-112 年)，執行民國 114 年核一、二、三廠緊急應變計畫區評估之檢討修正，評估包括核三廠全功率運轉階段與核一、二廠除役過渡階段前期。此外，本報告預先分析核三廠除役階段之緊急應變計畫區範圍(附件 A)，惟分析採用假設條件尚未經管制機關審查，其分析結果僅供參考。

評估結果揭示核三廠全功率運轉階段與核一、二廠除役過渡階段前期，以兩反應器之連線中點為圓心，在半徑 2.0 公里，若爐心設計基準事故發生時，皆滿足有效劑量小於 50 mSv，若爐心與用過燃料池熔損事故發生時，超出 50 mSv 與 2 Sv 之年機率亦皆分別小於 3.0E-05 與 3E-06。本評估揭示民國 114 年核一、二、三廠緊急應變計畫區之半徑為 2.0 公里，前述評估結果提供中央主管機關參考核定公告。

Abstract

This study reviews and revises the Emergency Planning Zones (EPZs) for Taiwan's nuclear power plants in accordance with Article 3 of the Enforcement Rules for the Implementation of the Nuclear Emergency Response Act. The assessment adopts the methodology from the 2022 EPZ study, together with updated meteorological data covering the period from 2019 to 2023. The evaluation is conducted for the 2025 EPZ reassessment of the Chinshan, Kuosheng, and Maanshan Nuclear Power Plants (NPPs).

The scope of this study includes the Maanshan NPP during the rated power (full-power operation) stage, as well as the Chinshan and Kuosheng NPPs during the pre-defueled stage (the decommissioning transition phase). In addition, a preliminary assessment of the EPZ for the Maanshan NPP during the spent fuel pool island operation period of the decommissioning phase is provided in Appendix A. However, the assumptions adopted in this analysis have not yet been reviewed or approved by the competent regulatory authority; therefore, the results are for reference only.

For the Maanshan NPP during the rated power stage and the Chinshan and Kuosheng NPPs during the pre-defueled stage, the results indicate that, using the midpoint between the two reactor units as the reference center, a 2.0 km radius EPZ satisfies the regulatory criterion that the effective dose remains below 50 mSv under a Design Basis Accident (DBA) occurring in the reactor core. For Severe Accidents (SAs) involving the reactor core or spent fuel pool, the annual probabilities of exceeding 50 mSv and 2 Sv are both below 3×10^{-5} and 3×10^{-6} , respectively.

These findings indicate that a 2.0 km radius EPZ is adequate for the 2025 assessment case. The results are submitted to the competent authority as a basis for consideration in EPZ designation and approval.

關鍵詞(Key Words)：核子事故緊急應變法施行細則(Enforcement Rules for the Nuclear Emergency Response Act)、核能電廠(Nuclear Power Plant, NPP)、緊急應變計畫區(Emergency Planning Zone, EPZ)。