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海底輸電線路故障定位技術開發

Development of Fault Location Techniques for Submarine Transmission Lines

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摘要

在隨著綠色能源的興起，各國相繼興建離岸風力發電系統。而海底電纜(海纜)是離岸風電系統主要傳輸電力的一個重要核心，其連接著離岸風場及陸域主電網。另外，像是台灣與澎湖之間也透過161 kV海纜將台灣本島的主電力系統連接至澎湖，以滿足該地區之用電需求。因此，海纜電力輸送的可靠性及穩健性一直倍受重視。為此，本文針對海底輸電線路發生事故時，進行精確找出事故地點之可行性評估。本文之技術是基於使用同步相量量測的雙端線路故障定位理論，再進一步推演出考慮到海纜電性耦合特性的演算法。同時間，本文針對安裝於各匯流排的電驛無同步化記錄波形資料之問題，評估出一種不受非同步時間量測影響的技術。因此，本文提出在不須同步化量測、無需進行疊代運算、不須假設任何參數(如電源阻抗及故障阻抗)之情況下皆能精準地定位出故障位置、並同步分析光纖感測技術於海纜故障定位等可行性。經由本文所提出的相關研究，當海纜發生事故時可精確得知故障地點、提高現場巡修船工程效率，進而提昇離岸電力系統的供電可靠度與強健性。

Abstract

With the rise of green energies, offshore wind farm construction is booming in many countries. Thus, submarine cables between offshore wind farms and the onshore power grid have played a key role in power transmission, e.g., the 161 kV submarine cables connecting power systems of Taiwan and Penghu. Accordingly, issues of reliability and robustness of submarine cables are highly concerned. To this end, this paper aims to assess the feasibility of identifying the fault location of submarine cables, based on a synchronized two-ended fault location technique and a new algorithm that further takes submarine-cable coupling and unsynchronized sampling into account. As a result, this paper presents a new fault location technique capable to precisely identify the fault location-unaffected by unsynchronized measurements caused by digital relays, free from iterative operations, no assumptions required, and simultaneously analyzing the feasibility of optical fiber sensing. The results of this study shows that when fault locations of submarine cables may be accurately identified, the

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engineering efficiency of repair ships can be enhanced, and reliability of offshore power systems improved.

關鍵詞(Key Words)：離岸輸電線路(Offshore Transmission Lines)、海底電纜(Submarine Cable)、故障定位(Fault Location)、非同步時間量測(Unsynchronized Measurements)、海纜電性耦合特性(Submarine-Cable Coupling Characteristic)、分佈式光纖感測技術(Distributed Optical Fiber Sensing Technique)、非疊代運算(Non-Iteration Operation)。

辦理台澎海纜交流耐壓試驗實例分享

On-site AC Test for Taiwan-Penghu 161kV Submarine Cable

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摘要

台電公司新建台灣~澎湖161kV電纜線路，其中海纜長度約58km，遠逾台電公司綜合研究所目前既有加壓設備之試驗能力，爰於台灣~澎湖161kV電纜線路統包採購契約中納入規定，由立約商以符合IEC60840-2004國際規範交流耐壓試驗能力之加壓設備，辦理本線路6條海纜交流耐壓試驗。因係台電公司首次採用歐洲新式自動變頻共振加壓設備，本案例分享特整理變頻交流耐壓試驗方法之理論及實務作基本介紹，以利相關人員能於未來台電公司綜合研究所亦採用類似之新式變頻加壓設備後，對於電纜線路之變頻加壓原理、使用設備項目及耐壓試驗流程等能有初步理解。

Abstract

Since voltage-withstand tests for the 58 km long Taiwan-Penghu 161kV submarine cable are beyond Taiwan Power Research Institute's (TPRI) capability, Taipower initiated a turnkey project to procure HVAC tests for the six submarine power cables. As specified in the contract, the HVAC tests can only be conducted with voltage-withstand test equipment in compliance with International Norms of IEC 60840-2004. Given that it is the first time that Taiwan Power Company adopts brand new Automatic Variable Frequency AC Resonant Test Equipment made in Europe, this article would like to introduce the theory and practice of Variable Frequency AC Voltage-withstand Test for cable conduits to serve as reference for TPRI's future practice.

關鍵詞(Key Words)：海底電纜(Submarine Power Cable)、現場交流耐壓試驗(AC Test on Site)、變頻共振加壓系統(Variable Frequency AC Resonant Test System)、變頻共振交流耐壓(ACRF)、變頻器(Frequency Converter)、電抗器(Reactor)、分壓器(Divider)。

壓入式沉箱工法對構造物之影響評估-以南崁溪及南崁溪支流段推管工程為例

Influence Evaluation of Press-in Caisson Construction Method for Structures-An Example of Nankan River and Its Tributary's Pipe Jacking Construction

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摘要

本案例為依據「大潭電廠燃氣複循環機組發電計畫」所規畫「161kV大潭新~林口地下管工程」之一部分，自大潭電廠增建161kV XLPE四回線複導體地下電纜沿既有道路佈設引接至林口電廠。新設161kV電纜管路全長約30公里，全程皆以地下電纜型式沿既有道路佈設。全線共分為三工區，本工程屬第三工區，全長約7.5公里。

地下電纜分為A線(北上)及B線(南下)，穿越南崁溪及南崁溪支流時將設置推管工作井(兼直井)，以推管之方式通過。本文將以南崁溪及南崁溪支流之推管段工程為例，以數值分析軟體Plaxis評估壓入式沉箱施工時對既有高速公路橋梁之影響。

Abstract

To execute the 161kV Datan-Shin~ Linkou Underground Conduct Construction Project, part of the Datan Combined Cycle Power Plant Expansion Project, the XLPE 4-circuits multiple-conductor 161kV underground cable from Datan G/S to Linkou G/S had been planned-the project is about 30 km long and divided into three work areas. This paper aims to introduce the third work area (TWA). The length of TWA is around 7.5 km, divided into line A (northbound) and Line B (southbound), and when passing through the Nankan River and its tributary, pipe jacking construction method had been applied. The said project may serve as an reference for evaluating the influence of press-in caisson construction method on highway bridges using Plaxis 2D.

關鍵詞(Key Words)：推管推進施工(Pipe Jacking Method)、壓入式沉箱(Press-in Caisson Construction Method)、數值分析(Numerical Analysis)、本案使用之穩定性分析軟體(Plaxis 2D)。

應用 ASCE 41-13 程序檢視台電大樓主樓之耐震評估 及結構補強案例分析研究

A Study of Seismic Performance Evaluation and Retrofit of Main Building Retrofit of
Taipower Headquarters Applying ASCE 41-13

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摘 要

本研究係以台電大樓主樓作為研究案例，由於此舊有建築物是依據當時設計時所採行之規範，可能已不符合現今規範之要求，且本大樓屬「建築物耐震設計規範及解說」第一類建築物，故有其執行之必要。研究方向原則採行美國既有建築物耐震評估與補強規範ASCE 41-13「Seismic Evaluation and Retrofit of Existing Buildings」之耐震評估及補強流程，並輔以我國「建築物耐震設計規範及解說」之條文規定，檢視本大樓結構之耐震評估及已完成結構補強之適切性。本大樓曾委託中興工程顧問股份有限公司於民國97年完成耐震詳細評估，並於民國99年完成耐震補強，由於當時評估之際所採行之規範與現行規範不同，本研究亦探討其差異之比較。

Abstract

This paper takes the seismic retrofit of the main building of Taipower headquarters as an example. The said building was built according to specifications and standards of that time, and is no longer in compliance with the latest regulations. Besides, the building pertains to the first type buildings specified in Seismic Design Specifications and Commentaries for Building Structures. Therefore, it is necessary to perform seismic performance evaluation and seismic retrofit, according to the procedures and methodology specified in ASCE 41-13, titled Seismic Evaluation and Retrofit of Existing Buildings, and the regulation of the Seismic Design Specifications and Commentaries for Building Structures. Worth mentioning, Taipower once entrusted Sinotech Engineering Consultants with a detailed seismic evaluation of the building in 2008, and the retrofit was completed in 2010. Considering the specifications of seismic performance evaluation and retrofit have been amended, we compare the influences caused by different specifications too.

關鍵詞(Key Words)：耐震評估(Seismic Performance Evaluation)、耐震詳細評估(Detailed Seismic Evaluation)、耐震補強(Seismic Retrofit)。

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國內電力設備 SF₆ 排放減量方法學應用

Application of SF₆ Emission Reduction Methodology for Domestic Power Facilities

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摘要

本研究依台電公司水力、火力、核能發電廠、供電及業務等單位，歷年SF₆回收設備維護操作情形，建置一套SF₆排放減量盤查表和相關佐證文件。依行政院環境保護署通過「電力設備現地回收SF₆排放減量方法(TM003)」，完成撰寫SF₆現地回收減量計畫之專案計畫書，並進行內部稽核。本減量專案於2019年11月23日取得「台灣電力股份有限公司電力設備現地回收SF₆排放減量計畫專案計畫書」第三者驗證公司確證聲明書，依此聲明書連同抵換專案申請書於2019年12月24日送環保署審完成減量專案之註冊申請(專案編碼B0000251)。

本研究協助此減量專案於2020年12月31日通過環保署之註冊審查。本減量專案計入期共計10年，各單位相關文件保存須至計入期結束後2年。配合台電公司SF₆管理制度，本研究協助建立一套台電公司六氟化硫排放減量盤查和稽核管理系統，以減少SF₆排放量與加強回收再利用之績效，並通過國際驗證公司的查證程序，協助台電公司向環保署申請減量專案並取得碳權。

Abstract

In this study, we established a set of SF₆ emission reduction inventory checklists and related supporting documents based on the maintenance and operation of SF₆ recovery equipment over the years for Taipower's hydraulic, thermal, nuclear power plant, power supply and business units. In accordance with the Methods for Reducing SF₆ Emission Reduction by On-site Recovery of Electric Equipment (TM003) enacted by the Environmental Protection Administration, Executive Yuan, we accomplished the SF₆ On-site Recovery and Reduction plan. After internal audits and obtaining certification statement issued by a third party verification company, the application of the offset project was submitted to the EPA on November 23, 2019 (project code B0000251), to complete the registration procedures.

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With assistance of this research, the reduction project passed EPA's registration review on December 31, 2020. The crediting period of the reduction project is 10 years in total. The relevant documents provided by relevant departments must be kept for at least 2 years from the end of the crediting period. In conjunction with Taipower's SF₆ management system, this research had helped Taipower accomplish the tasks of establishing a set of sulfur hexafluoride emission reduction inventory and audit management system to reduce SF₆ emissions and strengthen the performance of recycling and reuse, passing the verification procedures of international certification companies, and submitting the reduction project application to the EPA to obtain carbon rights.

關鍵詞(Key Words)：六氟化硫(Sulphur Hexafluoride)、減量方法(Methodology)、排放減量(Emission Reduction)。

林口電廠空污排放對環境 PM_{2.5} 及重金屬之影響 調查研究

Investigation on the Effect of Air Pollutant Emissions of Ambient PM_{2.5} and Heavy Metals for Linkou Coal-fired Power Plant

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摘要

為了增進民眾對我國電廠的空污改善成果，本研究針對林口超超臨界燃煤火力發電廠周界的PM_{2.5}、重金屬及陰陽離子等進行長時間的監測，再利用空氣品質模式及受體模式分析污染來源。在東北季風盛行期間(10月至4月)以林口電廠測站為上風，坑口測站為下風；西南季風盛行期間(5月至9月)以坑口測站為上風，林口電廠測站為下風。該研究執行期間10月至隔年4月之間執行2次每次至少21天，2年共114天的樣本；5月至9月期間執行1次每次至少21天，2年共69天的樣本，透過此長期監測結果以瞭解林口電廠對周遭空品的影響。前述監測數據將使用PMF模式進行PM_{2.5}及重金屬來源分析，進而推估林口發電廠的污染排放對周遭空品的影響。另利用CMAQ三維網格空氣品質模式模擬，及北部及竹苗空品區之空氣品質測站數據的統計分析，以了解林口發電廠的PM_{2.5}排放於不同季節對鄰近地區之空品影響。

Abstract

To enhance the public's recognition towards domestic power plants' efforts in reducing air pollution, this research conducts a long term monitoring on Linkou ultra-supercritical coal-fired power plant's ambient PM_{2.5}, heavy metals, soluble ions, etc. The air quality and receptor models are then used to analyze the source contributions-Linkou Power Plant (LPP) as the upwind site and the Kengkou station as the downwind site, during the months of northeast monsoon, from October to April next year; in the months of southwest monsoon, on the contrary. We conducted two samplings from October to April during this study; each lasted for at least 21 days, in total 114 daily samples collected in the two years. From May to September during this study, there

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conducted another sampling, also lasted for at least 21 days, in total 69 daily samples collected. Through this long-term study, it is hoped that the impact of LPP on the surrounding ambient air quality can be further understood. The PMF receptor model will be used to analyze the source contributions of PM_{2.5} and heavy metals to assess the impact of pollutant emissions from LPP. In addition, through the simulation of CMAQ three dimensional grid air quality model, and the statistical analysis of air quality data retrieved from the stations of the air quality districts of north Taiwan and Hsinchu and Miaoli, the influence of PM_{2.5} emission of power plants on the ambient air quality may be further understood.

關鍵詞(Key Words) : PM_{2.5}、超超臨界燃煤火力發電廠(Ultra-supercritical Co-fired Power Plant)、空氣品質(Air Quality)、重金屬(Heavy Metal)、汞(Mercury)、條件機率函數(Conditional Probability Function, CPF)、CMAQ空氣品質模式(Community Multiscale Air Quality Model, CMAQ)。

電力調度費成本分攤機制探討

A Study on the Cost Allocation Mechanism of Electricity Dispatching Service Fee

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摘要

本文旨在探討電力調度費成本分攤機制。電力交易平台成立後，台電調度處之業務除了原本的電力調度服務(SO)外，新增市場營運(MO)服務。為落實使用者付費原則，電力調度費中之調度服務成本分攤方式必須重新檢視。本研究蒐集國外調度中心成本分攤方式及收費項目，融合我國電業現況提出一套成本分攤方法。以2019年成本試算，SO及MO服務成本分別佔總成本之92.71%及 7.29%。此外，目前電力調度費率之設計係以總負載量做為分母計算，不適合作為MO服務費率計算使用。本研究提出以整年之輔助服務預估需求量為分母計算，使MO服務的費用，透過每筆達成的交易回收。

Abstract

This paper aims to explore a proper cost allocation mechanism for market operation service fee. Along with the establishment of Electricity Trading Platform (ETP), new measures of system operation (SO) and market operation (MO) services have been launched by the ETP. To enforce the user-pays principle, the cost allocation mechanism of these services needs to be reviewed. This study proposes a cost allocation method after reviewing foreign cases and integrating the embedded situations of the electric market in Taiwan. In 2019, the cost ratios of SO and MO services were 92.71% and 7.29% respectively. Currently, the calculation of SO fee uses total load demand as the denominator, which is not suitable for calculating the fee of MO service. Therefore, this study proposes that the calculation of MO service fee shall use ETP market demand as the denominator to recover its costs from market transactions.

關鍵詞(Key Words)：電力交平台(Electricity Trading Platform)、成本分攤(Costs Allocation)、電力調度費(Electricity Dispatching Fee)。

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