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協四機鍋爐降低氮氧化物排放之燃調測試評估研究

A Study on Combustion Adjustment Testing to Reduce the NOx Emissions of Hsieh-Ho Unit 4

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摘要

近年來協和發電廠屢受基隆市環保局關切，要求積極進行各項空污排放改善，其中針對協四機鍋爐氮氧化物(NOx)改善，提出限期於 108 年 6 月底前得減排 10%~15%之要求。

本計畫召開兩回合燃調前研討會，歷經大修期間查核燃燒設備與進行預備工作、完成各燃燒器均流調整改善後，接續在機組 155MW、440MW 等穩定負載狀況下，分兩階段施行鍋爐燃燒優化調整，最後在限期前圓滿達成本項 De-NOx 改善任務，成果如下：

(1)經優化燃調後高載 440MW 時達到 NOx 減量 16%(由 169ppm 降至 141ppm)，低載 155MW 時達到 NOx 減量 25%(109ppm 降至 81ppm)；(2)本計畫改善結果達成與增設 FGR 之相同成效(NOx 減量 10%~15%)，為公司擷節 3.6 億元巨額設備改善投資費用，有形效益極為顯著；(3)經如期達成 NOx 減量後，協四機 108 年起在空汙總量管制下每年可順利增加供電量及提昇電力系統備載容量，有效減緩公司供電緊澀狀況。

Abstract

The Environmental Protection Agency (EPA) of Keelung City expressed its concern about the air pollution emission of Hsieh-Ho Power Plant (HPP) and asked to reduce 10%~15% of the NOx discharged by Unit 4 by the end of June 2019.

The course of events and major results of this study are as follows. The course of events, two preliminary meetings called, combustion equipment inspected and prepared during the overhaul, burner balancing completed, and combustion optimization conducted respectively of 155MW and 440MW to reduce NOx emissions before the deadline. The results of this study: (1) after combustion optimization, the NOx of high load (440MW) had been reduced by 16% (from 169 ppm to 155 ppm), and the NOx of low load (155MW) reduced by 25% (from 109 ppm to 81 ppm); (2) the effectiveness of NOx reduction remained the same as FGR (10%~15% reduction required by the EPA), amounted to 360 million NTD equipment investment saving; (3) the NOx reduction target had been achieved before the deadline, enabling Unit 4 to increase output in 2019 under the restriction of total emission amount control, and helped mitigate the tightness of power supply.

關鍵詞 (Key Words)：燃燒器均流(Burner Balancing)、燃燒優化(Combustion Optimization)、氮氧化物(NOx)、爐膛燃振(Furnace Rumbling)、供電緊澀(Power Supply Constraint)。

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致災豪雨搶修經驗分享

-以 345kV 峨眉~中寮線#187 塔基搶修工程為例

The Experience of Emergency Repair - Taking 345kV Emei~Zhongliao Line #187
Transmission Tower as an Example

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Tseng, Chun-Jung

摘要

本案位於國姓鄉長豐村東三巷產業道路旁，因 108 年 8 月連日豪雨不斷，南投縣國姓鄉長豐村三隻寮產業道路(投 81 線)，長達 150 公尺的邊坡路段嚴重塌陷、路基掏空，隨時有大崩塌的危險。經南投線務段人員派員至現場巡視，發現於坍塌道路上坡側有本處 345kV 峨眉~中寮線#187 輸電鐵塔，研判無立即危險，但此區域早期可能有淺層滑動現象，造成投 81 線道路上邊坡出現張力裂縫後，經連日強降雨，地表逕流水流入張力裂縫後造成坡地整體滑動。

考量 97 年增設之基樁長度 10m，是否超越滑動破壞面且坐落於岩盤上，是否保護塔基之安全穩固，無法於事發當下立即評估，所以擬發包積點承攬商進行第一期的鑽探工程及第二期增設 20 支 20m 深之排樁結合地樑之保護工程，確實保障 345kV 超二路塔基及供電安全，文中將提及整個搶修過程經驗，並將施工遇到困難點提出探討與分享，供日後先進參考。

Abstract

The said case is by the side of an industrial road located in Guoxing Township, Nantou County. Due to lasting heavy rainfalls in August 2019, the slope of the road (about 150 meters long) was severely hollowed (Figure 1) and would collapse any time. After inspection by the personnel designated by Nantou District Office TPC, it was found that the sliding slope was merely 12 meters away from the 345kV Emei~Zhongliao Line #187 power transmission tower.

Although the foundation piles of the tower had been reinforced and extended to 10 meters in 1997, whether it was strong enough to protect the tower remained unknown. In this regard, a protection project to construct 20 20 meters long piles along with ground beam had to be initiated. The article introduces the whole course of the emergency repair to serve as reference for the company.

關鍵詞 (Key Words)：災修工程(Disaster Repair Works)、電力傳輸(Power Transmission)、擋土排樁(Retaining Pile)、邊坡穩定(Slope Stability)。

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二次變電運維管理資訊平台擴充開發研究

The Expansion of Maintenance Management Information Platform for Secondary Substations

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摘要

台灣電力公司以完善的輸配電系統將電力輸送到每一用戶端，輸配電力設備需要電力工程人員定期的巡檢與試驗，導入資訊化資料登錄可以有效地減輕工程人員的工作負擔。透過資訊系統融入巡檢與試驗作業流程，不僅對電力設備的檢測數據做有效地儲存與維護，亦能提升整體作業流程的工作效率。

本計畫目標為擴充現有二次變電運維管理資訊平台，增加的系統功能有對二次變電站巡檢作業加入 App 行動化數據填寫、派工作業管理、巡檢異常管理、設備事故管理、舊機電設備管理系統、斷路器以及設備維護功能。透過新開發的功能提升二次變電設備維護作業效率；此外，開發 Android 二次變電維護 App 支援設備的無線射頻系統(RFID)的掃描，提供現場人員更佳的巡檢或試驗作業操作。

Abstract

Stable power supply to consumers relies on regular facility inspections and tests by frontline electrical engineering personnel. The introduction of informationized data registration system (IDR) may reduce the workload of frontline engineers, record inspection data, ensure proper operation and thus enhance efficiency.

This research aims to expand the function of the present maintenance management information platform (MIP) of secondary substations by adding the features such as a mobile device App for electronic process inspection, a more comprehensive crew dispatch system, accident management, retired equipment management, circuit breaker management, and equipment maintenance to significantly enhance the facility maintenance efficiency of secondary substations. In addition, this research develops an android application for secondary substation maintenance with RFID on mobile devices to provide the frontline personnel with more convenient inspection and maintenance experience.

關鍵詞(Key Words)：管理資訊系統(Management Information System)、資料庫(Database)。

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配電設備周溫規範採用酷熱氣候標準可行性

A Feasibility Study on Adopting Extremely Hot Climate Standard for the Ambient Temperature Specifications of Power Distribution Equipment

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摘要

本研究針對配電設備之周溫規範採用酷熱氣候標準的可行性進行分析。由於現行導線類、開關類、變壓器類、自動線路開關類及電容器等重要配電設備，其環境溫度規範係依據 IEC 60694 國際標準，以戶外溫度 $-10^{\circ}\text{C} \sim +40^{\circ}\text{C}$ 以下訂定；但近年來氣溫逐年升高，為避免因環境周遭氣溫升高而引發配電設備故障，因此本研究主要希望能夠透過各個角度來審視思考未來配電材料周溫規範採用酷熱氣候標準之可行性。主要探討的議題有三：首先，針對台電現行導線類、開關類、變壓器類、自動線路開關類及電容器等重要配電設備，評估其未來是否得以承受目前夏季連續 35°C 以上高溫考驗。其次，研究未來配電設備之周溫規範其採用酷熱氣候作為標準之可行性分析。最後，針對配電設備，提出未來應對酷熱氣候，其周溫規範之可行改善策略與影響評估。

Abstract

The purpose of this study is to analyze the feasibility when adopting extremely hot climate standard for the ambient temperature specifications of power distribution equipment. According to the international standard IEC 60694, the ambient temperature specifications for power distribution equipment such as power lines, switches, transformers, automatic line switches and capacitors, are set in the range of -10°C to $+40^{\circ}\text{C}$ according to the outdoor temperature. However, affected by climate change, the temperature is increasing year by year. To avoid failures of power distribution equipment caused by extreme temperatures, this study aims to analyze the feasibility when adopting extremely hot climate standard for the ambient temperature specifications of power distribution equipment from various perspectives, namely (1) to evaluate whether the equipment such as power lines, switches, transformers, automatic line switches, capacitors of Taiwan Power Company (TPC) are able to withstand the test of lasting high temperature (equal or above 35°C in summer); (2) to analyze the feasibility when adopting extremely hot climate standard for the ambient temperature specifications of future power distribution equipment; (3) to propose improvement strategies and influence assessment for distribution equipment against extremely hot temperatures.

關鍵詞 (Key Words): 酷熱氣候(Extremely Hot Climate)、熱改良性紙(Thermally Upgraded Paper)、最熱點溫度(Hottest Spot Temperature)、光纖傳感器(Optic Fiber Sensor)、風險管理(Risk Management)。

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透過事故資料分析發電機勵磁系統組耐受度並修正快速隔離故障標置之需求

The Endurance of Generator Excitation System Analyzed with Event Data and the Modification of IED IIT Setting Label

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摘要

為提升離島系統穩定度快速隔離故障是相當重要的，如何在饋線主斷路器 FCB 端進行瞬間跳脫元件(Indicating Instantaneous Trip, IIT)標置是一件相當重要的問題，如何合理的評估發電機組的韌性，及系統饋線最大/最小故障電流，皆會影響保護電驛標置。

設定 IIT 需考量的是系統的故障電流在多大的情況下需快速的隔離故障防止系統崩潰，加上現今饋線自動化議題，為了使 FDIR 功能可以正常的判斷電流是否為事故電流至少需要一定的反應時間，故本文透過歷史事故電流進行機組自動電壓調整器(Automatic Voltage Regulator, AVR)反應及耐受力評估，減少當事故發生時發電機 AVR 系統轉換為手動狀態之可能性進行 IIT 標置分析。

發電機組在加入系統時，相關工作人員需要對其進行各項試驗，以利發電機組的質量評估，通常這些試驗包含了：開路試驗、加壓試驗、保護功能試驗及機組穩定試車幾小時試驗，然部分控制器或其他電機控制標準，實際現場面是不會執行的，故本文透過事故資料進行更加有意義的分析。

Abstract

To improve the power system stability of outlying islands, it is extremely important to isolate faults in no time. The marking of indicating instantaneous trip (IIT) at the end of main feeder circuit breakers (FCB) is an important issue for example. The setting of IIT has to consider the magnitude of fault current so as the fault may be isolated right away to prevent power system collapse. At the request of feeder automation, the fault detection, isolation, and service restoration (FDIR) function needs some reaction time to assure that is an accident current. In this regard, this paper conducts AVR response and tolerance assessment of the generator through historical accident current to reduce the possibility of accidents that the generator AVR system would have been switched to manual state, and accordingly conducts IIT calibration analysis.

關鍵詞 (Key Words)：瞬間跳脫元件(Indicating Instantaneous Trip, IIT)、自動電壓調整器 (Automatic Voltage Regulator, AVR)、開路試驗(OCC)。

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非傳統資源參與北美 ISO 輔助服務之制度蒐集

A Study on the Eligibility Required for Non-conventional Resources to Provide Ancillary Services - the Cases of Northern America ISOs

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摘要

本文以電力系統輔助服務中之調頻備轉、即時備轉與補充備轉為研究主軸，並以北美 5 個 ISO 之輔助服務制度及規範作為參考依據，探討儲能、需量反應及自用發電設備此三種非傳統資源於輔助服務之參與機制、應提供之服務、以及所需具備之設備條件。

為了解北美 ISO 開放非傳統資源參與輔助服務之設計考量，本研究著重於各 ISO 對於輔助服務參與資源之技術規格要求與參與機制，包含：可參與之項目、最小參與容量、資源控制方式、反應時間、達成容量時間、持續執行時間等，並說明各 ISO 對各非傳統資源之特殊規範。與輔助服務之交易市場規則相關議題，例如：競標、服務效益驗證、結算與罰則等，則未納入本研究之討論範疇。

Abstract

This study focuses on the eligibility of non-conventional resources such as energy storage, demand response, behind the meter generator to provide ancillary services (AS) as follows: frequency regulation, spinning reserve and supplemental reserve. Based on the literature review of the market manuals and protocols of independent system operators (ISOs) in Northern America, the qualification of non-conventional AS resources including the eligibility to participate, minimum capacity of the bid, control scheme, response time, activation, duration and so forth have been discussed. Besides, specific practices of each ISO have been examined to further understand the reasoning of a system operator introducing new resources onto the market. Nevertheless, market regulations such as bidding rules, performance measurements, settlement and penalty are excluded from this study.

關鍵詞 (Key Words)：輔助服務 (Ancillary Service)、儲能(Energy Storage System)、需量反應 (Demand Response)、自用發電設備(Behind the Meter Generator)。

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再生能源對電力系統慣量之影響探討與分析

The Effects of Renewable Energy on Power System Inertia

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摘要

傳統電力系統中因同步發電機組的轉子慣量(Inertia)很大，故系統頻率可由同步發電機組的轉子轉速決定，在電力系統發生功率變動時，旋轉慣量可提供功率支撐系統頻率，提升電力系統的頻率響應。但未來風機和太陽光電等再生能源占比將逐漸提高，再生能源的慣量要比傳統機組的慣量小，在負載變動時，易使頻率偏離目標值。尤其未來白天時段傳統同步發電機組出力大幅降低，許多傳統機組可能待機或解聯，進一步導致系統慣量不足。系統慣量不足，將使頻率響應變差，如又發生跳機或短路等偶發事故時，易造成系統穩定度問題。本文收集再生能源加入對電力系統慣量影響案例與應用對策，並利用一電網模擬再生能源匯入對慣量的影響，所得結果可提供再生能源占比提高後電力系統運轉調度之參考。

Abstract

Due to the large rotor inertia of synchronous generators for conventional power systems, the system frequency may be determined by the rotor speed of synchronous generators. When system load changes, the rotational inertia may provide functions such as frequency support and frequency response. In the foreseeable future, the volume of renewable energy such as wind turbines and solar photovoltaics will gradually increase. Nevertheless, the inertia of renewable energy is less significant than traditional generators. The system frequency is apt to deviate from target value when system load changes, especially in the daytime when the output of synchronous generators is low (many traditional generators stay on standby or disconnected). This will further lead to insufficient system inertia and then worsens the capability of frequency response. When the said situation collides with generator/line tripping or short circuit, poor frequency response may cause serious problems of system stability. This study aims to collect the cases and countermeasures regarding the impacts of renewable energy and simulate the impacts of renewable energy. The results of this study may serve as reference for power system operation confronted with high penetration of renewable energy.

關鍵詞 (Key Words) : 同步發電機 (Synchronous Generator)、再生能源 (Renewable Energy)、頻率響應 (Frequency Response)、系統穩定度 (System Stability)。

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台灣輔助服務及備用容量交易試行平台之交易機制簡介

The Experimental Ancillary Service and Reserve Margin Trading Platform in Taiwan

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摘要

我國推動電力交易平台之主要動力來自於能源轉型。電業法第十一條規定輸配電業依電力市場發展之需要，應於廠網分工後設立公開透明之電力交易平台。惟考量電力交易平台之運作模式屬國內首次推動，有必要在電力交易平台正式運作前，先行確認平台機制設計及運作之可行性及穩定性。經濟部爰而責成台電公司辦理「輔助服務及備用容量交易試行平台」之設立及營運事項，並訂定其應適用之管理規範及作業程序。輔助服務係指為完成電力傳輸並確保電力系統安全及穩定所需要的服務資源，包含調頻備轉、即時備轉、補充備轉及其他必要輔助服務。相對而言，備用容量則係指為確保長期供電穩定，由售電予用戶之電業準備適當備用供電容量。台電公司設立及營運試行平台的核心概念，係在電網穩定的前提下，引入「電源供給端」及「負載需求端」的電力資源，透過試行平台進行競價交易，達成電力交易之「公平競爭」與「公開透明」之目標。

Abstract

Energy Transition is one of the key components driving Taiwan to launch an electricity trading platform. Besides, Article 11 of the Electricity Act specifies that the licensee of transmission and distribution (i.e. the system operator) shall according to the needs of market development establish an open and transparent electricity trading platform. Being a first push in Taiwan, it is necessary to examine the feasibility and reliability of the platform before it is officially launched. Therefore, the Ministry of Economic Affairs instructed Taipower to initiate the Experimental Ancillary Service and Reserve Margin Trading Platform and enact regulations related to the platform's management and procedures. Ancillary services (AS) including frequency regulation, spinning reserve, supplemental reserves are technical measures to ensure stable and real time power system operation. Comparatively, reserve margin (RM) helps secure steady power supply in a longer term. The retailers (power companies that sell electricity to consumers) are obliged to prepare adequate generation capacity (the reserve margin). In short, the trading platform aims to procure supply and demand side resources under the premise of grid security and to realize a fair, open and transparent electricity market transaction.

關鍵詞 (Key Words)： 交易試行平台(the Experimental Trading Platform)、輔助服務(Ancillary Services)、備用容量(Reserve Margin)。

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台電公司電力物聯網通訊系統導入研究

A Preliminary Study on Introducing Electric Power Internet of Things into Taipower

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摘要

本研究計畫以發展、建立台電公司最適未來通訊網，以滿足各種電力設備通訊需求，使台灣成為科技生活智慧島之計畫。本計畫以金門離島做為智慧電網通信規劃之示範場域提供適用智慧電網發展所需之電力物聯網通信系統建置及光纖布建基礎建設。研究計畫分為網路規劃與技術/效益評估、系統建置/運轉測試、示範應用系統驗證，並分成三階段進行：第一階段從 107 年 12 月至 108 年 12 月完成初步基礎建設及物聯網設備研發驗證，第二階段從 108 年 12 月至 109 年 6 月完成終端設備連通於電力物聯網，最後階段從 109 年 6 月到 109 年 12 月完成台電示範應用場域建置。本篇主要以第一階段工作為主，介紹電力物聯網專網建置與導入的流程，並以金門場域建置及金門展示測試為例，提供台電階段性評估內容與初步結果。

Abstract

The purpose of this study is to develop an optimal communication network matching the needs of various electrical equipment. This project takes Kinmen as a demonstration field and seeks to transform it into a smart island of technology and life by developing an electric power IoT communication system and fiber optic infrastructure.

This study is divided into three phases: the phase of network planning and feasibility and benefit evaluation (Dec 2018 to Dec 2019), the phase of system installation and operation test (Dec 2019 to Jun 2020), and the phase of demonstration application and system verification (Jun 2020 to Dec 2020). This article focuses on the first stage of work to serve as reference for the company to evaluate the initial results.

關鍵詞 (Key Words)：智慧電網 (Smart Grid)、電力物聯網 (Electric Power Internet of Things)、專網(Private Network)。