

摘要

本報告在探討核三廠執行大幅度功率提升(Extended Power Upgrades, EPU)，對核電廠安全度評估之人為可靠度的衝擊。研究中篩選出 39 項人為誤失事件，重新評估人為誤失機率。所採用的人為可靠度分析模式為 HCR (Human Cognitive Reliability) 與 THERP (Technique for Human Error Rate Prediction)；HCR 模式中所需之人員動作允許時間係應用 MAAP4.0.4 程式，針對功率提升後之電廠的熱水流狀態進行分析。研究中探討人為誤失機率的改變對於早期大量輻射外釋 (Large Early Release Frequency, LERF) 與爐心熔損頻率 (Core Damage Frequency, CDF) 的影響；並依據重要度分析的結果，找出提升後，對風險有較大影響之人為動作。

核三執行 EPU 後，因爐心功率提升使得運轉員的反應時間被壓縮，而進行重新計算人為誤失機率的人為誤失事件共有 12 項，大部分為暫態事故與蒸汽管束破裂事故之下對於爐心冷卻水系統進行補水或洩壓的人為誤失事件；以及冷卻水流失事故之下的後備高壓注水動作和爐心冷卻復原的程序動作。以上人為誤失機率的增加，使得 CDF 由原來的 $7.33 \times 10^{-6}/\text{year}$ 升高至 $8.24 \times 10^{-6}/\text{year}$ ，LERF 由原來的 $1.69 \times 10^{-7}/\text{year}$ 升高至 $2.43 \times 10^{-7}/\text{year}$ 。由重新評估後的結果可找出 LERF 與 CDF 的 F-V 重要度或 RAW 變化較大之人為誤失事件，提供核三廠執行功率提升後關於人為誤失機率之參考，予電廠風險告知的資訊。

ABSTRACT

In this report, the impact of extended power uprates (EPU) on the human error probability (HEP) in the frame work of Probability Safety Assessment (PSA) of Maanshan Nuclear Power Station(NPS) is studied. The plant analyzed employs a Westinghouse designed three-loop pressurized water reactor. The Human Cognitive Reliability (HCR) and Technique for Human Error Rate Prediction (THERP) models are used to quantify the HEPs. The available time of the specified human actions is estimated using MAAP4.0.4 integrated system analysis code. The impact of the HEPs on the core damage frequency (CDF) and large early release frequency (LERF) is also studied.

Based on the available time of the specified human actions and the importance analysis of the plant specified PSA, 39 human actions are identified for the present study. The results of the present study show that the HEPs of the human actions related to the emergency injection and depressurization during the general transition, the loss of coolant accident, and the steam generation tube rupture change significantly when the power uprates is implemented. The HEPs of 12 human events are affected by power uprates of Maanshan NPS. As demonstrated in the present study, the CDF increases from $7.33 \times 10^{-6}/\text{year}$ to $8.24 \times 10^{-6}/\text{year}$, and LERF increases from $1.69 \times 10^{-7}/\text{year}$ to $2.43 \times 10^{-7}/\text{year}$ due to the increases of HEPs above these 12 human events.