Contribution ID: **99** Type: 口头报告

基于设备可靠性预计的核电厂丧失厂用水系统始发事件频率定量化方法研究

摘要

风险监测器以核电厂运行阶段 PSA 模型为基础，已广泛应用于核电厂的在线风险监测，为运行与维修活动提供辅助决策支持。其中，以丧失厂用水系统为代表的支持系统始发事件是风险监测器中必不可少的一类始发事件。在风险监测器中需要根据特定的外部环境（如高温、风暴潮等）调整该类始发事件在特定环境下的发生频率，目前风险监测器中这类始发事件频率的修正主要基于专家判断，不能准确的体现核电厂的真实风险水平。本文基于机械设备可靠性预计方法，提出了一种根据关键环境影响因素对特定环境下丧失厂用水系统始发事件发生频率进行定量化和修正的方法。此方法包括关键环境因素的确定、关键因素参数与设备可靠性参数关系的拟合、厂用水系统关键能动设备可靠性参数的修正等，并通过蒙特卡洛抽样方法模拟厂用水系统运行状态，从而更为真实地对电厂始发事件频率进行在线修正，为风险监测器的应用提供支持。

关键词

支持系统、始发事件频率、可靠性参数修正、核电厂风险监测器

Abstract

To provide auxiliary decision-making support for operation and maintenance activities in nuclear power plants, the risk monitor is built on the probabilistic safety analysis (PSA) model of the operation phase, and has been widely used in online risk monitoring. It is an essential type of initiating event from support system represented by the loss of plant water system in risk monitors. And the frequency of such events should be revised according to specific external environments, say high temperature or storm surge. However, that correction in risk monitors is based on expert judgment at present and it cannot reflect the risk level of nuclear power plants on time and accurately. This paper proposes a novel method, based on the reliability prediction method of mechanical equipment, to quantify and correct the initial event frequency of loss of service water systems by selecting the key environmental influencing factors. This method is realized by steps of selecting key environmental factors, determining the relationship between those factors and equipment reliability parameters, and correcting the reliability parameters of key active equipment in the plant water system, then the operating state of this system is simulated through Monte Carlo sampling method. Compared to expert judgment, this method is more suitable and practical to support for the application of risk monitors.

Keywords

Support system, initiating event frequency, reliability parameter correction, risk monitor of nuclear power plant

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Session Classification: 安全科学与技术

Track Classification: 03 口头报告: 安全科学与技术