Insights from the Wolf Creek Nuclear Generating Station
Fire PRA

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Abstract

The Wolf Creek Generating Station Fire PRA was completed in 1994 and 1995 by Wolf Creek Nuclear Operating Corporation with support from NUS Corporation. The Fire PRA was performed using an initial fire area screening employing the methodology, followed by the application of Fire PRA techniques on unscreened fire areas. The results of the Fire PRA showed that switchgear fires were the dominant fire scenario for Wolf Creek. The results, however, were considered conservative, due to the lack of a vigorous and accurate method for treating electrical cabinet fires, including propagation within a cabinet, propagation through cabinet penetrations, treatment of spurious valve operation and the ability of fire suppression to extinguish a cabinet fire.

1.0 INTRODUCTION

Wolf Creek Generating Station (WCGS) is a Standardized Nuclear Unit Power Plant System (SNUPPS) design located in Burlington, Kansas (USA). The primary system is a Westinghouse four-loop PWR design, and the plant received its operating license in 1985. Since the plant is of newer design and construction, the fire separation and suppression throughout the plant is excellent. In addition, the major pumps and components are compartmentalized, with very few large combustible loads contained within connecting corridors. Because of this, the Fire PRA results were expected to be very good. However, since the plant was designed with a two train Class 1E (or safety related) electrical system, it became evident early in the analysis that fires affecting an entire Class 1E AC power train, such as switchgear fires, would dominate the Fire PRA results.

The Wolf Creek Fire Risk Evaluation was performed in response to the NRC's request for Individual Plant Evaluation for External Events [1]. The Fire Risk Evaluation was performed using an initial fire area screening from the EPRI Fire-Induced Vulnerability Evaluation (FIVE) methodology [2]. FIVE uses a progressive screening approach based upon quantifying: (1) the frequency of the fire ignition in specific plant areas, (2)
based upon quantifying: (1) the frequency of the fire ignition in specific plant areas, (2) the availability of automatic suppression systems, (3) the probability of having sufficient combustibles and heat release to cause damage to shutdown systems, and (4) the probability of manual suppression effectiveness. The FIVE methodology was used for the initial screening, ignition source frequency calculations, fire compartment interactions analysis, and walkdown portions of the fire analysis.

Following the initial FIVE screening, Fire PRA techniques were used on unscreened fire areas to determine a more accurate estimate of the fire-induced plant core damage frequency. The detailed fire PRA techniques included the use of COMPBRN IIIe for fire modeling, as well as event tree analysis for more complex fire scenarios. Additionally, probabilistic fire spreading from area to area was considered.

One of the main objectives of the fire PRA was to be able to use the analysis results for applications in a similar way to the Level I PRA results. One application was the planned inclusion of the fire PRA results in the development of a Safety Monitor™ for support of on-line maintenance scheduling. Therefore, the Fire PRA models had to be developed in sufficient detail to ensure accurate fire scenarios and reasonable core damage frequency results.

### 2.0 FIRE PRA METHODS AND RESULTS

A total of 133 fire areas were analyzed during the initial FIVE analysis. Twenty one (21) fire areas screened during the FIVE qualitative screening steps, with 105 fire areas screening during the FIVE quantitative screening steps. The remaining 7 areas included three switchgear rooms, two Auxiliary Building Corridors, and two electrical penetration rooms. These fire areas were then analyzed using detailed fire PRA techniques. A total of 62 ignition sources in the 7 fire areas were analyzed in detail using a combination of event tree and COMPBRN analysis.

An example of an event tree used for the detailed analysis is shown in Figure 1. This figure shows the analysis of a fire starting in an electrical cabinet, MCC NG01B. In this case, the cabinet contains cables associated with safe shutdown equipment (SSE). Additionally, there are SSE cables traveling directly overhead of the cabinet and still more SSE cables overhead and within approximately 20 feet of the cabinet. The cabinet is sealed with a fire retardant material, however, testing has not been performed to establish a fire rating for the installed configuration. Data from NSAC/178L [3] was used to derive a probability of fire propagation from cabinets such as these. A probability of non-propagation of 0.85 was derived from the data. Extinguishing a fire prior to propagation can occur from; 1) manual suppression, 2) self extinguishing of the fire, and 3) automatic suppression functions prior to propagation.

Once propagation from our example cabinet was determined to occur, the unavailability of automatic fire suppression was considered. In this case, a Halon fire