⟨Technical Note⟩

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ASSESSMENT OF WIND CHARACTERISTICS AND ATMOSPHERIC DISPERSION MODELING OF ^{137}Cs ON THE BARAKAH NPP AREA IN THE UAE

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This paper presents the results of an analysis of wind characteristics and atmosphere dispersion modeling that are based on computational simulation and part of a preliminary study evaluating environmental radiation monitoring system (ERMS) positions within the Barakah nuclear power plant (BNPP). The return period of extreme wind speed was estimated using the Weibull distribution over the life time of the BNPP. In the annual meteorological modeling, the winds from the north and west accounted for more than 90 % of the wind directions. Seasonal effects were not represented. However, a discrepancy in the tendency between daytime and nighttime was observed.

Six variations of cesium-137 (^{137}Cs) dispersion test were simulated under severe accident condition. The ^{137}Cs dispersion was strongly influenced by the direction and speed of the main wind. A virtual receptor was set and calculated for observation of the ^{137}Cs movement and accumulation. The results of the surface roughness effect demonstrated that the deposition of ^{137}Cs was affected by surface condition. The results of these studies offer useful information for developing environmental radiation monitoring systems (ERMSs) for the BNPP and can be used to assess the environmental effects of new nuclear power plant.

KEYWORDS : Meteorological Modeling, Return Period, Atmospheric Dispersion, ^{137}Cs Dispersion, Barakah Nuclear Power Plant (BNPP), ERMS

1. INTRODUCTION

The construction of the Advanced Power Reactor 1400 (APR1400) is planned for completion in the Barakah area. ERMS is one of the safety assessment system that is planned for installment in the BNPP. An ERMS that can detect continuous and real-time gamma dose rates is an important element in determining emergency conditions and long-term data acquisition, and it is among numerous types of radiation monitoring systems. Therefore, the correct position of an ERMS must be determined to effectively monitor radiation level. Meteorological characteristics play an important role in determining the ERMS position in a nuclear power plant. Uncontrolled release of radioactive materials occurs in the reactor containment area, and, the direction of the dispersion path of such materials is strongly influenced by meteorological characteristics.

Based on a literature review, an evaluation of international ERMSs (Table 1) has demonstrated that many ERMSs in Europe and Korea have been installed using an empirical methodology instead of a scientific approach [1,2]. Numerous ERMSs are established in equal intervals along the site boundary or throughout population concentration areas. In the US, ERMSs are not used; instead, the dose assessments are performed with portable measurement devices along the boundaries of nuclear power plants [3,4].

As a preliminary study to evaluate optimal ERMS positioning, this paper focuses on analyzing the meteorological characteristics of wind and simulating the ^{137}Cs dispersion under hypothetical accident condition in the BNPP area. Actual weathering data, near the BNPP area were obtained from the National Center of Meteorology and Seismology (NCMS) UAE and, processed to estimate the return period of wind speed using the Weibull distribution model. The return period of wind speed is

Table 1. International Status of the ERMS Installation and Monitoring

Country	ERMS Monitoring
Korea	10-12 Points/Site & 1-2 Comparative Points/Site
US	-
France (BSL Site)	4 Points within 1 km of the Site & 4 Points within 5 km of the Site
UK (Dungeness Site)	-
Germany (Krümmel Site)	3 Points

widely used in architecture engineering to determine the wind-load effect on high-rise structure vibrations and in wind power research. Kim et al. [5] studied the return period of wind speed using the Weibull and Gumbel distribution model for 8 major cities in Korea. Chung performed an evaluation of the extreme value distribution of wind pattern by the Gumbel model simulation for 3 cities in Korea [6].

The effects of wind distribution and ^{137}Cs dispersion at the BNPP were simulated with annual weathering data, land-use data, and upper-air data according to the CALPUFF (California Puff) code, which has been evaluated as a high performance atmospheric simulation code.

The next section of this paper discusses the environmental characteristics of the Barakah area; the 3rd section describes the methods and simulation model; the 4th section discusses the results of the study; and conclusions are presented in the 5th section.

2. ENVIRONMENTAL CHARACTERISTICS OF THE BARAKAH AREA, UAE

The BNPP is located approximately 250 km from the western area of Abu Dhabi, UAE [7] (Fig. 1), and the Arabian Gulf is north of the site. The area of the BNPP site is relatively flat with no mountains.

According to an environmental report on the UAE [8], the entire nation has an extremely arid subtropical desert climate, and the main climate of the UAE is characterized by two seasons, summer and winter. The UAE has extremely high temperatures with a relatively humid climate because of coastal weather from the Arabian Gulf in the summer season, which is generally from April through September. In winter, which is generally from October through March, the UAE has a warm and dry climate. More than 70 % of the annual precipitation falls in the winter season.

The environmental report notes that the mean annual temperature in the UAE is approximately 28 ºC. The winter temperature regime is characterized by warm and sunny weather with daytime temperatures that reach be-

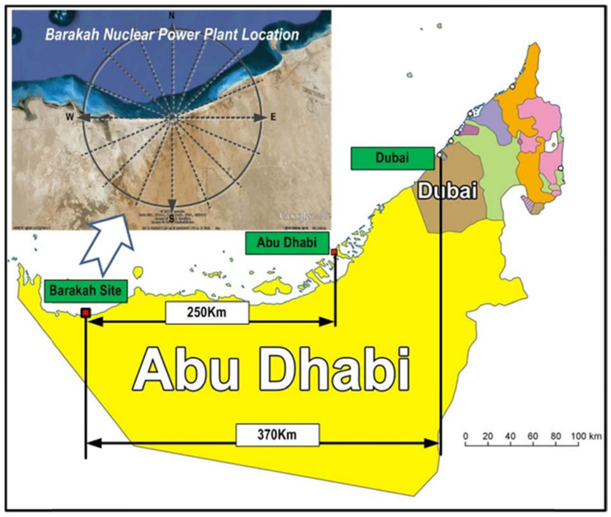

Fig. 1. Map of the United Arab Emirates and the BNPP Location

tween 23 and 24 ºC. The summer temperatures are often above 38 ºC.

There are two dominant mechanisms for wind direction: passing weather systems, which are influenced in the long-term by seasonality, and land-sea breeze, which changes between day and night as a result of the temperature gradient between land and sea, especially in coastal areas.

3. DESCRIPTION OF METHODS AND MODELING

3.1 The Return Period of Wind Speed using the Weibull Distribution

Before the development of ERMS or EPZ (emergency planning zone), available data that pertain to wind speed predictions for the future can be used as basic information for safety design in nuclear power plant. The return period of wind speed was calculated for the estimation of the extreme wind speeds in the BNPP area. The return period of wind speed is an estimation of the annual, monthly, and daily extreme wind speed occurring in the future based on historical wind speed data. There are various statistical methods to calculate the return period of wind speed. Ha et al. indicated that the annual and, monthly extreme wind speed distribution patterns follow the Gumbel distribution model [9,10]. Whereas, Cook insisted that the daily extreme wind speed distribution is consistent with the Weibull distribution model [11]. Rehman et al. suggested that wind speed was well represented by the Weibull distribution function in desert area [12]. In this paper, the daily extreme wind speed was calculated using the Weibull distribution model using data from the 3 most recent years. Because of limits in the acquisition of weathering data, the estimation of the annual and monthly extreme wind speed cannot be performed.