Transactions of the Korean Nuclear Society Autumn Meeting
Goyang, Korea, October 24-25, 2019

Management of the Meteorology Section for Technical Siting Requirements

Sungchul Jang [a], Eric Yee [a*]
[a]*Department of NPP Engineering, KEPCO International Nuclear Graduate School (KINGS),*
658-91 Haemaji-ro, Seosaeng-myeon, Ulju-gun, Ulsan, Korea 45014
[*]*Corresponding author: eric.yee@kings.ac.kr*

1. Introduction

The first thing to be done in the new Nuclear Power Plant (NPP) construction project is the site selection of where to build the NPP (called a siting), and it is particularly important to investigate a thousands of parameters for reserve sites for proper site selection during the NPP project. These parameters are characteristics such as location of planned sites, population, traffic conditions, nearby industries, power grid accessibility, and data such as average temperature, humidity, wind, wind speed, and precipitation at candidate sites, which are closely related to many technical disciplines such as meteorology, hydrology, geology, and seismology and so on.

Nuclear Regulatory Commission (NRC) recommends including the data and methods of investigation of the parameters of the selected site when submitting documents such as Preliminary Safety Analysis Report (PSAR) and Environmental Impact Assessment (EIA), which are necessary for the construction and operation authorization of NPPs and it is integral of the stable and suitable construction and operation of NPPs. Therefore, investigations into incorrect or insufficient parameters are not only cost-side, but also a major factor in the failure of the NPP construction project. As a result, it needs systematic and accurate methods and implementation of data investigations.

However, this parameter survey is not simply about a single technology field, but it is more related to many disciplines and needs many experts in meteorology, geology, geography, hydrology, seismology, and so on to conduct a comprehensive and systematic investigation.

This paper addresses the need for parameter investigation for successful NPP siting, and among other things, only meteorological parameters and their methods of investigation.

2. Background

2.1 Safety aspect

Stability of nuclear power plants is very critical as everyone knows. To ensure NPP reliability effectively, it requires accurate and effective analysis and management of parameters in many fields, such as meteorology, hydrology, and geology and so on. The NPP physical damage caused by incorrect site selection can be contaminated near the plant due to radiation leakage, atmospheric diffusion and contaminated water generation, which can have an absolute adverse impact on the safety and life of nearby residents as well as the destruction of the natural ecosystem.

2.2 Cost aspect

The importance of parametric surveys of planned sites in selecting NPP sites is more significant in terms of cost. Examining thousands of parameters requires a large number of resources, both tangible and intangible, including the use of observational equipment and the time it takes to investigate, and the investigation itself is costly. Above all, if the NPP construction project is carried out after site selection based on poor or mis-measured parameter data, it could result in uncontrollable situations in the future, which could make all the costs invested in the project meaningless.

3. Parameters for meteorology section

According to the U.S NRC, For stationary power reactor site applications submitted on or after January 10, 1997, 10 CFR 100.20(c) (2) requires consideration of the meteorological characteristics of the site that are necessary for safety analysis or that may have an impact upon plant design in determining the acceptability of a site for a nuclear power plant and also applicants for NPP project need to establish and maintain a weather program that can quickly evaluate important meteorological parameters [1].

In this section, some basic and important meteorological parameters which are also necessary for PSAR and EIA are stated below.

3.1 Ambient temperature

Ambient temperature is a measure of the hotness or coldness of the ambient air. For the range of ambient temperatures for sites, usually weather data issued by the National Meteorological Administration (KMA in Korea) are referred.

Data requirements are maximum, minimum, and mean temperature (monthly, seasonally, yearly), no specific requirements for the period of temperature data for site parameters, but usually monitored at 10 meters (33 feet) and 50 meters (165 feet) for atmospheric stability and at least 30 years data are recommended.

Liquid-in-glass (mercury thermometer, alcohol), Electrical Thermometers are used to measure. For the thermometer to measure the actual air temperature, the thermometer shall be installed and observed so that it is not directly affected by radiation through suitable masking or shielding devices. The best location for temperature observation is an instrument screen installed in a flat surrounding area, where the sun or wind are not obscured or obstructed from trees, buildings or other obstacles.

3.2 Vertical Temperature Difference(ΔT)

The measured difference in ambient temperature between two elevations on the same tower. It is defined as the upper level temperature measurement minus the lower level temperature measurement.

There's no specific requirements for the period of temperature data, vertical temperature difference should be measured on the same open-lattice tower or mast as wind speed and wind direction between the 10-meter (33-foot) level and 60-meter (197-foot) levels. For more upper air observation, Radio zone, aircraft, Raywin, etc. are mainly used as meteorological observations up to an altitude of about 80 km from the surface, and weather satellites and weather rockets are also used.

3.3 Relative Humidity

The ratio of observed water vapor pressure to saturated water vapor pressure in water at the same temperature and air pressure is expressed in %. At sites utilizing cooling towers, cooling lakes and ponds, or spray ponds as the plant's normal heat sink, atmospheric moisture measurements like Dew Point Temperature should be included. Data Requirements are maximum, minimum and mean humidity (monthly, seasonally, yearly) measurements should be made to avoid air modification by heat and moisture sources and also 30years data or equal quality is needed (in the same manner as temperature). Psychrometer, hygrometer (laminate, hair, resistive, etc.) are used to measure and a psychrometer, a wet-and-dry-bulb thermometer, consists of two thermometers, one that is dry and one that is kept moist with distilled water on a sock or wick and devices that indirectly measure humidity by sensing changes in physical or electrical properties in materials due to their moisture content are called hygrometers. Some materials, such as hair, skin, membranes, and thin strips of wood, change their length as they absorb water.

3.4 *Wind speed and direction*

Wind speed literally means the speed of the wind, which can be described as the speed of the vertical horizontal flow of air and is generally defined as having only two-dimensional vectors: vertical and velocity components. Wind direction means wind direction, which is added 10° by turning clockwise from the geographically northern direction.

Data requirement are wind speed, direction, duration of wind direction, maximum instantaneous wind speed and information about wind should contain both average wind field and instantaneous wind information, rather than instantaneous information, wind observation devices should include data processing and recording systems as well as observation sensors.

Anemometer is used to measure and it is used in the form of wind direction indicator wing and cup, and wind speed system is used in the form of directional wing and so on. The wind gauge for wind direction shall be so designed that it does not react vertically. Since most cup-propeller wind speed sensors tend to react quickly to acceleration while slow to react at deceleration, the rotational speed may tend to be over-estimated compared to the actual wind speed. To overcome these side effects, it is better to select a wind speedometer that responds quickly to deceleration.

3.5 Atmospheric Dispersion

The purpose of analyzing weather data at sites of nuclear power plants is to assess the ability of the atmosphere to diffuse, so the atmospheric characteristics at a site are an important consideration in evaluating the dispersion of radioactive effluents from both postulated accidents and routine releases in gaseous effluents.

Actually, radiation doses associated with airborne radioactive materials from routine releases and anticipated operational occurrences must be kept "as low as is reasonably achievable" (ALARA). Gaussian Plume Model is used to measure and calculate which is basic atmospheric dispersion model that assumes that the plume spread has a Gaussian distribution in both the horizontal and vertical directions This is a simple mathematical model used to estimate the concentration of pollutants at a point at some distance from the source of emission. This model is used for static as well as mobile sources of emissions. In this model, the dispersion in the three dimensions is calculated. Dispersion in the downwind direction is a function of the mean wind speed blowing across the plume. Air pollution is represented by an idealized plume coming from the top of a stack of some height and diameter.

3.6 Precipitation

Precipitation is a liquid or solid form of matter in which water vapor condenses into the ground or is deposited into the air, with rain, hail, snow, dew, frost, frost, frost, fog, etc. The total precipitation is defined as the vertical depth of precipitation when the precipitation reached the ground over a specified period of time is converted into water. Snowfall is defined as the depth of snow that has been lowered and covered by the ground. In units of precipitation, mm (volume/area) or kg/m2 (mass/area) are used for liquid precipitation.

Precipitation meters (or rain gauges) are the most commonly used precipitation observation. Generally, a rain gauge has a container at the top that collects precipitation, and a cylinder that measures the precipitation collected below, and the overall shape is a funnel. The height of the rain gauge or the size of the hole depends on the country or institution and there is no clearly defined standard. However, the height of the rain gauge shall be higher than the maximum snow level and higher than the height at which the precipitation particle bounces off the ground, usually 50cm to 1m [2].

Meteorological parameters used in the construction of NPP #5, 6 are listed below in Table 1.

Table 1: Meteorological parameters list used in Shin Gori #5, 6 NPPs [3]

Meteorology	Local climate	Climate, precipitation, (relative) moisture, wind, fog, etc.
	Local meteorological conditions required for design and operation criteria	Design weather condition due to storm, Maximum (instantaneous) wind speed, wind direction, persistence of wind, precipitation, tornado, hail, snow, estimated maximum rainfall in the winter for 48 hours, yellow dust phenomenon, possibility of air pollution, atmospheric stability, sea breeze, etc.

4. Conclusions

As previously explained, parameters of the candidate site prior to and during plant construction and operation should be given to PSAR and EIA, and they are very important as they can affect all structures, systems and components of the NPP, even environment. In this study, although only meteorological parameters have been addressed, however, it is expected to help understand the importance of the siting management and investigation of parameters for successful NPP projects.

ACKNOWLEDGEMENTS

The authors thank the other members of the group of project management for NPP construction and Hyojung Kim, David Kessel, and the professors who gave special lectures.

This paper was supported by the 2019 Research Fund of KEPCO International Nuclear Graduate School (KINGS), Republic of Korea.

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