A Statistical Reconstruction Method for Determining 99.5th Percentile Atmospheric Dispersion Factors from ARCON96 Frequency Distribution Tables

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Keywords: ARCON96, RG 1.194, RG 1.145, MCR, TSC, EAB, LPZ, 99.5th percentile, Monte Carlo simulation

ARCON96 has been widely used under U.S. Nuclear Regulatory Commission (NRC) Regulatory Guide 1.194 for evaluating atmospheric dispersion factors (X/Q) associated with onsite receptors, including main control room (MCR) habitability assessments. According to Regulatory Guide 1.249, recent regulatory developments have expanded the application of ARCON96 to Exclusion Area Boundary (EAB) and Low Population Zone (LPZ) consequence assessments through NRC-approved 99.5th percentile atmospheric dispersion methodologies supporting Regulatory Guide 1.145 applications. However, ARCON96 does not directly provide the exact 99.5th percentile atmospheric dispersion factors required for these evaluations.

This study presents a statistical reconstruction methodology for determining 99.5th percentile atmospheric dispersion factors directly from ARCON96 frequency distribution tables. Analysis of ARCON96 outputs showed that the atmospheric dispersion factor intervals are arranged as a geometric progression with a constant ratio of 1.09. Monte Carlo simulations further identified the representative location within each interval, enabling the establishment of percentile-bin relationships for the reported frequency distributions. Based on this framework, the atmospheric dispersion factors immediately above and below the target percentile are identified and interpolated to obtain the exact 99.5th percentile value.

The proposed methodology was implemented in an automated computational tool and verified using NRC benchmark cases. The calculated results agreed with reference solutions within 0.01%, demonstrating excellent accuracy and numerical robustness.

The developed approach provides a practical and statistically rigorous method for reconstructing NRC-approved 99.5th percentile atmospheric dispersion factors from ARCON96 outputs and supports regulatory applications involving MCR, TSC, EAB and LPZ radiological consequence assessments.

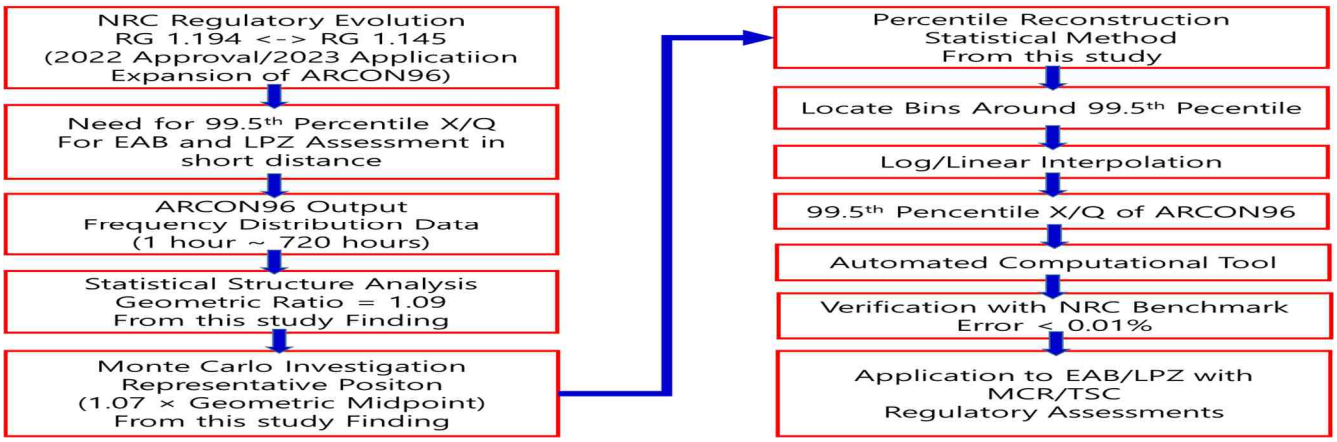

Fig. 1. Methodological Framework for Reconstruction of 99.5th Percentile Atmospheric Dispersion Factors from ARCON96 Frequency Distribution Tables

Acknowledgement

The present study was performed as part of the radiological consequence assessment for Main Control Room (MCR) Design Basis Accidents (DBAs).