Analysis of Gamma Shielding Evaluation Codes Based on Point Kernel Methodology

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Introduction

☐ Necessity of radiation dose evaluation of workers

- In general, the radiation dose of workers is higher than that of the public, and accordingly, it is necessary to optimize the radiation dose.
- Performance of radiation dose evaluation should be preceded when establishing a work plan for optimizing workers' radiation dose.

☐ Necessity of gamma shielding evaluation codes based on point kernel methodology

- The point kernel methodology is a radiation dose assessment methodology which requires less computational time than others.
- It can calculate the radiation dose by various types of sources by performing iterative calculations.
- Prior to the development of a worker radiation dose evaluation program, it is necessary to investigate and analyze gamma shielding evaluation codes based on the point kernel methodology.

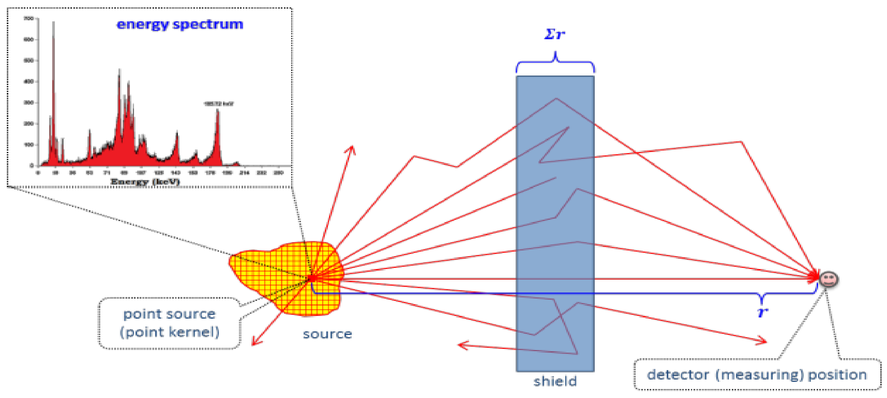

Fig 1. Point kernel method process

Objective

■ Analysis with gamma shielding evaluation code based on point kernel methodology

- To Investigate and analysis of QAD-CGPIC code, IGSHIELD code, 3DGShield code

Analysis with gamma shielding evaluation code

☐ QAD-CGPIC code

- QAD-CGPIC code is an improved version of the QAD codedeveloped by the Safety Research Institute, AERB in 2001.
- It evaluates doses by applying a point kernel methodology to calculate neutron and gamma shielding through various shielding configurations.
- Based on the QAD code, QAD-CGPIC had been improved to select gamma ray build-up factor suitable for more complex geometry implementations and dose rate calculations.

Table 1 : Characteristics of QAD-CGPIC code

Categories	Specifics
Code language	- Visual Basic and Fortran
Build-up factor	- Select Geometric Progression build-up factor or Carpo's build-up factor
Characteristics	- Handles off centered multiple identical sources - Provides plots of buildup factors (ANSI-1990) and material cross sections - Interactive input of geometry with 3D view - Unable to handle thickness greater than 40 mfp

☐ IGSHIELD code

- It is a gamma ray shielding evaluation code developed by Subbaigh and Sangapani in 2008.
- It applies a point kernel methodology based on the QAD-CGPIC (QAD-CGGP) code.
- It had been improved to support more complex shielding configurations than previously developed codes.

Table 2 : Characteristics of IGSHIELD code

Categories	Specifics
Code language	- Visual Basic and Fortran
Build-up factor	- Select Geometric Progression build-up factor or Carpo's build-up factor
Characteristics	- Process various multi-source shapes such as points, lines, planes, and other bulk sources in a single operation - System geometry is immediately displayed on a 3D display for the user to make the necessary modifications - Unable to process some 3D irregular shapes of sources

☐ 3DGShield code

- 3DGShield code is a gamma ray shielding code developed by Manoj Kumar Hansda, Shaji Mammento in 2021.
- It can assess the irregular 3D type sources that cannot be processed in the QAD, IGSHIELD codes.

Table 3 : Characteristics of 3DGShield code

Categories	Specifics
Code language	- Python-2.7
Build-up factor	- Geometric Progression Build-up factor
Characteristics	- Ability to handle any type of complex source geometries and irregular source shapes - Modeling any kind of regular and irregular complex multilayered shield geometries - Having provision to export the output results into ParaView, an open source data analysis and visualization software, for quick visualization and analyzing of the results - Increased computation time due to complex geometry

Conclusion

■ In this study, we analyzed gamma shielding codes based on point kernel methodology.

■ We analyzed QAD-CGPIC code, IGSHIELD code, and 3DGShield code with gamma shielding codes based on point kernel methodology.

■ Each code has been improved for complex forms of source implementation.

■ Each code differs depending on the code language, the number of build-up factor, and how irregular the source forms are implemented.

■ The results of this study can be used to perform dose evaluation to reduce exposure of workers in nuclear power plants with various types of sources.

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