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Analysis of Photon Energy Distribution at the Working Places in Nuclear Power Plants and Application to the Lead Vest Shielding

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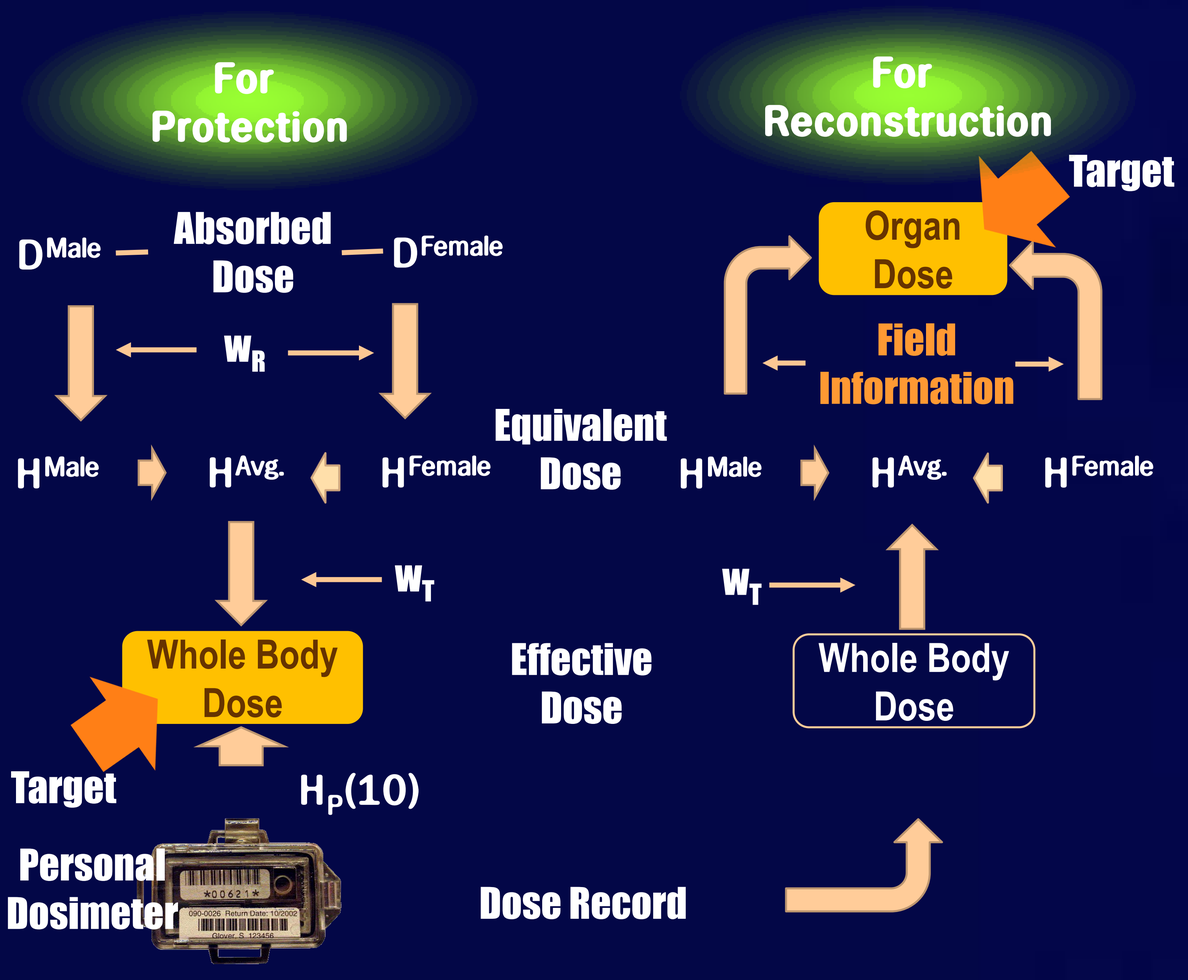
Introduction

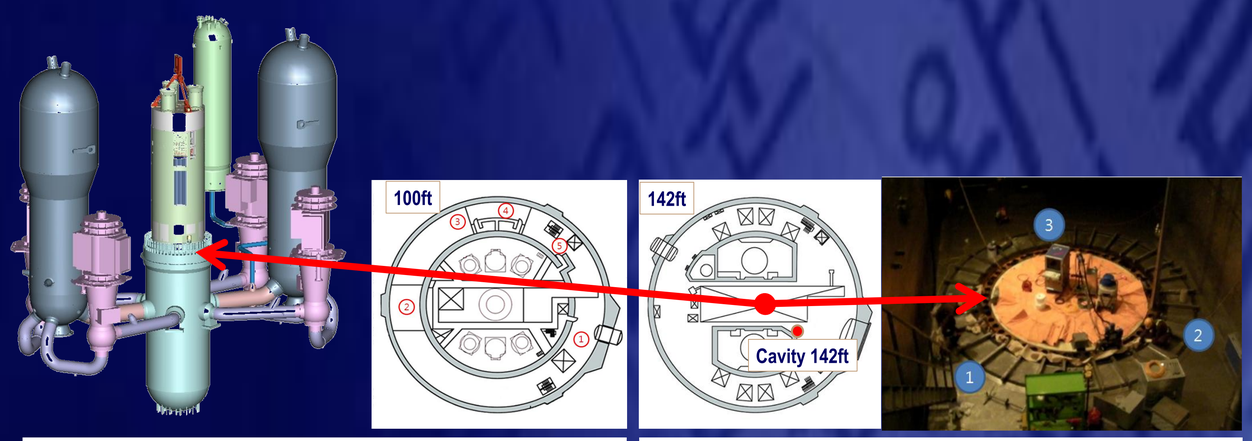
Radiation Field Information in nuclear power plants should be provided for optimal job planning and worker's dose management. It can be categorized with radiation type, incident direction, energy distribution and dose rate for external exposures. Survey meters and multiple personal dosimeters are used to obtain the information but the energy distribution analysis is not generally carried out.

Photon energy distribution information can be used to design proper shielding for high dose jobs or to reconstruct worker's organ specific doses.



Results

Results showed that mean photon energies were about 0.2 to 0.6MeV. For all working places, the mean photon energy was lower than the standard photon energy for personal dosimeter calibration.

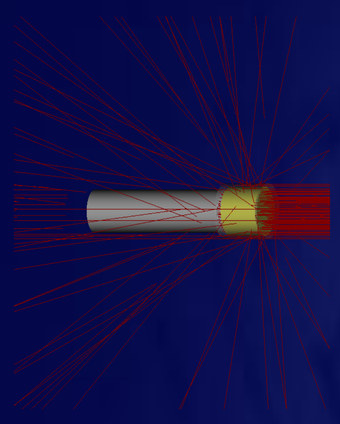


Photon energy distribution field survey results at some working places

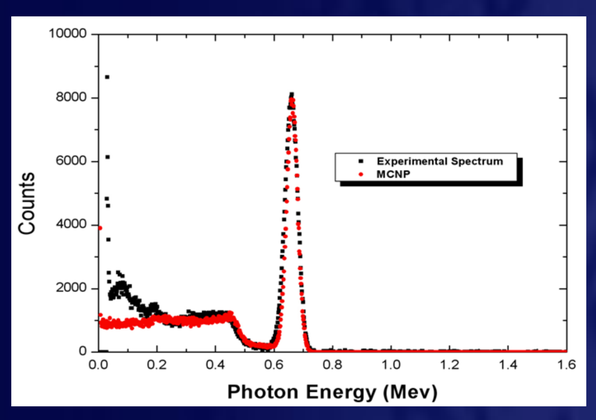
Job/Working place	Mean photon energy [MeV]
Steam Generator nozzle dam installation	0.28 - 0.58
Steam Generator man-way open	0.36 - 0.37
Steam Generator Eddy current test	0.28 - 0.44
Steam Generator tube	0.28 - 0.44
Reactor Head inspection	0.24 - 0.42
Stud Hole inspection	0.39 - 0.46
Reactor cavity decontamination	0.21 - 0.31
In-site inspection	0.30 - 0.38
Reactor Coolant Pump inspection	0.25 - 0.35
Low dose area	0.26 - 0.37

Materials and Methods

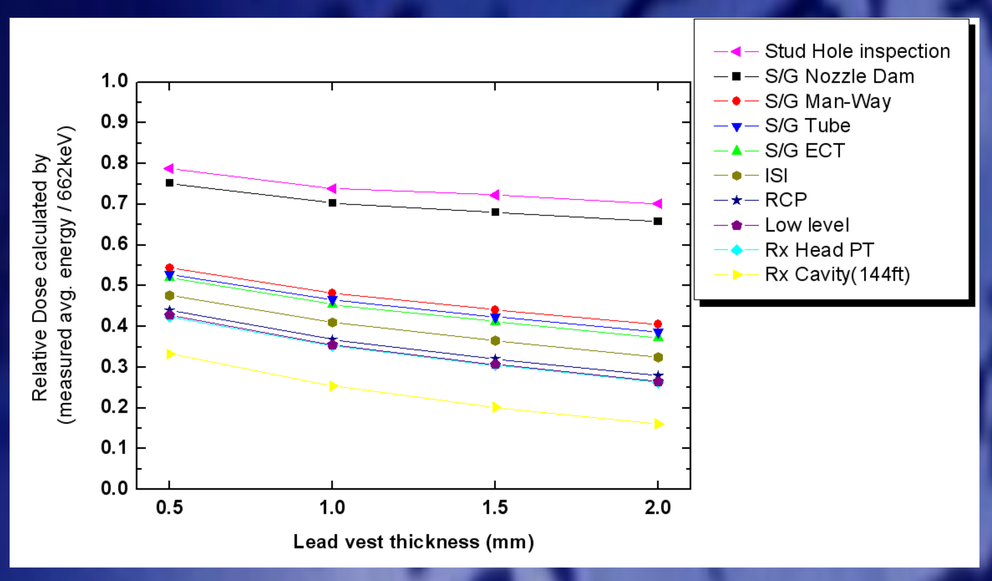
Working places for photon energy distribution measurements were selected by high collective dose jobs in PWRs(Pressurized Water Reactors) during O/H(Overhaul; Refueling Outage) periods. A portable NaI scintillation counter with Multi-Channel Analyzer was used. Monte Carlo calculations based on in-situ calibration methods were also carried out.



The portable NaI scintillation counter(left) irradiated by Cs-137 source for calibration and its MCNPX modeling (right)



Comparison of the experimental measurements with calculations



Actual shielding efficiencies calculated by MCNPX with MIRD phantom

Conclusion

- Photon energy distributions for various working places in nuclear power plants were measured.
- The mean photon energy was lower than the standard photon energy for personal dosimeter calibration.
- From the results, standard radiation fields applied to personal dosimeter calibration is considered to be conservative for radiation protection.
- Also, the radiation doses to the worker with lead vest were much lower than estimated by mono energy photon.
- Measured photon energy distribution information will be applied to radiation optimization and organ dose reconstructions for radiation induced cancers of workers in nuclear power plants.

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