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Construction of a head phantom for mixed neutron and gamma field dosimetry in TRR

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Abstract

Boron Neutron Capture Therapy (BNCT) project in Tehran Research Reactor (TRR) is currently ongoing and an appropriate neutron beam for BNCT has been provided by modification of TRR thermal column. In order to measure the neutron beam characteristics inside of a phantom, a standard phantom is needed. The present paper describes details of the head phantom construction and its different potential. The constructed head phantom permits us to put different dosimeters with different sizes in many locations of the phantom volume. Foils, wires, TLDs and ion chamber can be placed inside of its volume. Gel dosimeter can also be poured into the phantom volume and removed from it easily.

Keywords: mixed neutron and gamma field; BNCT; Tehran Research Reactor; head phantom;

1. Introduction

BNCT project at Tehran Research Reactor (TRR) is currently ongoing and a thermal neutron beam for BNCT has been constructed by modification of TRR thermal column (Kasesaz, et al., 2014). To perform the necessary dosimetric studies at this facility, an appropriate phantom is needed. BNCT dosimetry is rather complicated because of the presence of the four dose components acting with different Relative Biological Effectiveness (RBE). These dose components including: 1- boron dose (D_B): the dose from ^{10}B (n,α) ^{7}Li reaction. 2- Gamma dose (D_γ): the dose from neutron beam and $^{1}H(n_{th},\gamma)^{2}H$ reaction. 3- (D_{th}) thermal neutron dose: The dose resulting from thermal neutron capture in nitrogen $^{14}N(n_{th},p)^{14}C$. 4- fast neutron dose (D_f): the dose from the $^{1}H(n,n')^{2}H$ reaction (IAEA-TECDOC-1223, 2001). These dose components should be measured separately. Commonly thermal neutron dose and boron dose are measured by activation technique and KERMA factor approach. Gamma and fast neutron doses are measured using dual ionization chamber. Usually tissue equivalent (A-150) and graphite walled ionization chambers are used. Gamma dose measurement may also be performed with small Thermo Luminescent Dosimeters (TLDs) (Wolfgang S, 2012). An appropriate phantom for BNCT dosimetry should be capable to