3. SUPPLEMENTARY INFORMATION

3.1 Phenomenon of radioactive decay and the radiations

The radioactive decay or transformation involves transformation of the unstable radioactive nucleus to attain a more stable configuration. As the nucleus contains protons and neutrons, such transformations involve reactions of these sub-atomic particles. In a simplified manner, it could be stated that the stability of the nucleus predominantly depends on the total number of nucleons (protons and neutrons) as well as the ratio of the protons (p) to the neutrons (n). While nearly all the isotopes beyond element Bismuth (atomic number 83) are radioactive as the total number of nucleons become too large for stability, the lower atomic number elements have stable isotopes as well as radioactive isotopes, depending on the p/n ratio and certain other properties of the nuclide. Generally, a proton rich (or neutron deficient) nuclide would transform to reduce the proton content; while a neutron rich nuclide would transform vice versa. A very heavy radionuclide may attain stability by shedding some nucleons. Such transformations may involve the emission of charged particles, capture of an electron from the extra-nuclear orbits by the nucleus, also known as electron capture (EC) or isomeric transition (IT). The charged particles emitted from the nucleus may be alpha (α) particles and beta (β) particles or gamma rays.

The decay of a radionuclide is governed by the laws of probability with a characteristic decay constant (λ) and follows an exponential law. The time in which a given quantity of a radionuclide decays to half its initial value is termed the half-life ($T_{1/2}$).

Each radionuclide is characterized by an invariable $T_{1/2}$, expressed in units of time and by the nature and energy of its radiation or radiations. (*See new item "Units of energy".*)

The penetrating power of each radiation varies considerably according to its nature and its energy. Alpha particles, which are the heaviest among the radiations, have the minimum penetration, followed by the beta particles, and gamma rays have the most penetrating power. Alpha particles can be stopped within a thickness of a few micrometers to few tens of micrometers of matter, while beta particles require several millimeters to several centimeters of matter for complete attenuation. Gamma rays, on the other hand, are the most penetrating and are attenuated in an exponential manner in matter. High density materials, such as lead, are used to reduce the gamma rays and a ten-fold reduction of energetic gamma rays may require several centimeters of lead. The denser the material used, the higher the attenuation of radiations.