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Working toward a long-term secure supply of medical radioisotopes

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Abstract No. 1085

Learning Objectives: The OECD Nuclear Energy Agency (NEA) has become actively involved in international efforts to improve the security of supply of molybdenum-99 (99Mo) and its decay product, technetium-99m (99mTc), the most widely used medical radioisotope. The NEA established the High-level Group on the Security of Supply of Medical Radioisotopes (HLG-MR) in April 2009. The main objective of the HLG-MR is to strengthen the reliability of 99Mo and 99mTc supply in the short, medium and long term.

The HLG-MR has examined the major issues that affect the short-, medium- and long-term reliability of 99Mo/99mTc supply. The collective efforts of HLG-MR members and nuclear medicine stakeholders have allowed for a comprehensive assessment of the key areas of vulnerability in the supply chain and an identification of the issues that need to be addressed. Significant progress has already been achieved on improving the supply situation through increased communication, co-ordination of reactor schedules and a better understanding of demand-management opportunities. Continued action is required on the part of all stakeholders. In addition, the NEA has released three reports under its "Supply of Medical Radioisotopes" series, subtitled: "An Economic Study of the Molybdenum-99 Supply Chain"; "Interim Report of the OECD/NEA High-level Group on the Security of Supply of Medical Radioisotopes"; and "Review of Potential Molybdenum-99/Technetium-99m Production Technologies". The paper present comprehensive information on the supply chain and possible changes needed to ensure a long-term secure supply of 99Mo. The historical development of the market has an impact on the present economic situation, which is currently unsustainable. The economic structure therefore needs to be changed to attract additional investment in production capacity as well as the necessary reserve capacity. The paper presents options that could be considered in that regard. the paper will also present other key findings from the work of the HLG-MR.

Research Support: Some member countries have provided voluntary contributions to support the work of the HLG-MR

State of the art method for containment and disposal of liquid and solid radioactive waste using a molten aluminum alloy reactor

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Abstract No. 1086

Learning Objectives: Disposal methods of low and high level medical and reactor radioactive waste have been proposed and used including storage, burial, activated carbon, vitrification into borosilicate glass or released into the environment. We evaluate a new method of using a CTIC molten alloy reactor.

Methods: Feed material without pretreatment such as radioactive contaminated medical waste can be introduced into the molten aluminum alloy bath reactor with other proprietary ingredients at 700 degrees C and above resulting in chemical reduction followed by remediation of the molecular structures. Results: The molten alloy reactor appears well-suited for treating a spectrum of isotopic materials including contaminated or biohazard organic compounds. Radioactive materials dissolved or melted into the reactive metal can be concentrated to the desired level of activity with the option of adding photon absorbing metal. With the biohazard organic material reduced the concentrated isotopes may be drawn off to form cooled alloy ingots. The advantage of this chemical reduction based waste treatment process is that it is non-selective, since waste materials of biologic or ogranic compounds can be processed at one time. All of the chemical reduction reactions decompose molecular bonds at the liquid aluminum temperature of 700 degrees C and above. We have found a 84% reduction of total volume of material when processed in the alloy bath. Special electric fields are utilized to direct the charged beta particles into beta absorbing material. Conclusions: This state of the art disposal method for radioactive waste allows seperation of large biohazard or contaminated isotopic material has significant advantages to concentrate and store radioactive isotopes as alloy ingots as a solution for long term storage. Seperation of non radioactive and radioactive material and marked reduction of large volumes of biological or organic compounds is a significant advantage to other accepted modalities

3-Dimensional simulation of nuclear medicine laboratory construction

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Abstract No. 1087

Learning Objectives: In addition to work-flow and circulation, effective medical service must be considered in connection with the architectural design of a hospital. Thus, it is rather intricate to design an efficient hospital in all aspects. Moreover, in the designs of laboratory facilities of a hospital, laboratory-specific requirements must be kept in mind too. Radiation protection is added to the some important considerations in designing nuclear medicine laboratories. Recently, 3-dimensional modeling has been increasingly used in various fields of architecture. Author applied 3-dimensional modeling to the design of a nuclear medicine laboratory in a hospital.

Methods: In consideration with work-flow, circulation, medical service and radiation protection, a nuclear medicine laboratory facility was 2-demensionally designed. From 2-demensional design, 3-dimensional modeling has taken a place to improve work-flow, care-giving, infection-prevention, circulation, radiation protection and humanistic environment. All items were discussed carefully in a team of architects, engineers and doctors. A final decision was made by the consensus of the team members. In a case that the items conflict with each other, a decision followed the predetermined order. Results: With an application of 3D-simulation, ineffective or less effective components of nuclear medicine laboratories were corrected into more effective ones and more radiation-protective structure. Conclusions: 3D-simulation was effective in correcting an inefficient or wasteful space deployment and in improving workflow. However, the applied 3D-simulation methods showed limited performance in improving practice-specific issues. Therefore, in the future, advanced and integrated 3D-simulation methods such as BIM may be warranted

Building innovation capability-evaluation on the production of Tc-99m isotope with the TR30-15 cyclotron

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Abstract No. 1088

Learning Objectives: Tc-99m-based compounds are widespread in clinical use for SPECT diagnosis. Tc-99m (half-life: 6.01 hours, 142 keV, only emits gamma rays and decays to Tc-99) is used in nuclear medicine for a wide variety of diagnostic tests. Traditionally, Tc-99m formed through the decay of Mo-99 (beta decay, with a half life of 66 hours) reaction, which is one of the fission products of U-235. One gram of Tc-99m produces 6.2x108 disintegrations a second (that is, 0.62 GBq/g).

Methods: Institute of Nuclear Energy Research (INER) recently proposed advancing INER's TR30/15 cyclotron system to produce medical Tc-99m isotope that would fulfill the technetium needs locally. INER's TR30/15 cyclotron, the only 30-MeV cyclotron of its kind in Taiwan, is available for those in the global nuclear medicine industry interested in a cyclotron that can produce PET and SPECT isotopes including Tc-99m, F-18, Tl-201, In-111, I-123, Co-57 and Ge-68. Results: To implement this novel approach, INER is proposing the direct production of Tc-99m on the 30-MeV cyclotron as an alternative to reactor produced Mo-99/Tc-99m generator technology. The cyclotron option for the supply of Tc-99m would be an important strategy because it would build new innovation capabilities for INER, the recombination existing cyclotron technology, logistic capacity, redundant beam line, target/irradiation skills, expertise/knowledge and operating diversity. Conclusions: The aforementioned innovation-infrastructure will offer many sustainable advantages and tangible/intangible capability for the INER. We do not only catching market-niche but also building innovation-capability from the evaluation on the production of Tc-99m isotope with the TR30/15 cyclotron in Taiwan

Cyclotron produced F-18 radionuclide: O-18 enriched water validation of the INER TR30/15 Cyclotron in Taiwan

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Abstract No. 1089

Learning Objectives: Cyclotrons are currently used for the preparation of a wide variety of radionuclides that find application in positron emission tomography (PET) as well as in single photon emission computed tomography (SPECT). For F-18 radiopharmaceuticals, limits of impurities of unwanted radioisotopes are well-defined for labeling. Written procedures to document the operation of the cyclotron should ensure that all intended operating parameters will be followed. Most PET target materials, like O-18 enriched water, are not manufactured in PET centers. Therefore, it is essential that the PET center validate the quality of the target materials. Consequently, the O-18 enriched water quality specification should be adequately specified and appropriately validated.

Methods O-18 enriched water should be controlled in order to produce the radioisotope of required radionuclidic specifications. The raw materials (enriched water) used in F-18 production would be required to be of certain specifications with an acceptable range of enrichment, and the cyclotron beam energy clearly defined. We graph the curves for O-18(P,N)F-18, O-16(P,A)N-13, O-17(P,N)F-17 incident energy and reaction cross-section with different F-18, N-13, F-17 irradiation doses. The actual enrichment of O-18 enriched water can be calculated. Results The irradiation energy parameters derived from the above assessment are used in cyclotron irradiation to generate the best yield and the minimal other nuclides. The experimental irradiation parameters are as follows: 1. Irradiation energy: 2.5~29.5 MeV 2. Accelerated particle: proton 3. Beam current: 17~18 micro-A 4. Irradiation time: 1 hrs Conclusions It can be known the aforementioned curves for the O-18 enriched water proves to be predictive and controllable. Moreover, the irradiation products have consistent quality. Therefore, the present results have proved to possess industrial usefulness, novelty and progressiveness

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