QUESTION 7

GIVEN: five accident scenarios as stated in the question and designated by numbers (1) through (5) respectively in answers below.

SOLUTIONS AND ANSWERS:

A. Five actions listed by highest priority 1 through lowest priority 5 in response to a radiological accident involving personal injury are summarized:

- 1. Provide first aid needed for survival of injured person if radiation field and other environmental conditions permit it; otherwise, remove injured person first from any life threatening environment.
- 2. Call for needed emergency medical, fire, and other support personnel according to emergency plan. This should have almost as high a priority as 1, and if possible other people present in the area might initiate these calls at the same time 1 is initiated.
- 3. Monitor victim for contamination, and with the aid of emergency medical personnel wash wounds of any radioactive contamination and remove contaminated clothing from accident victim; save all washings and clothing for later detailed analyses of the activity of all radionuclides.
- 4. With the aid of emergency medical personnel, provide diuretics, blocking agents, or chelation agents to enhance excretion of radionuclides if the condition of the accident victim allows and if the magnitude of the estimated intake warrants such medical interventions.
- 5. Remove and evaluate dosimeters to estimate the victims dose for future medical guidance.

B. The preferred bioassay procedure for each specified accident 1 through 5 is given and justified:

- 1. Urinalysis for Pu-239 because of direct uptake into the blood from the wound and the lack of significant photons associated with the decay of Pu-239.
- 2. Urinalysis for H-3 because of direct uptake into the blood through the skin and the lack of significant photons associated with the decay of H-3.
- 3. Whole body count for high yield 0.662 MeV gamma photons following external decontamination because all inhaled Cs-137 is assumed to be in the relatively transportable compound class D and essentially all ingested Cs-137 is taken directly up into the blood and rapidly distributed throughout all soft tissue in the body.
- 4. Urinalysis for S-35 because of direct uptake into the blood from the small intestine and the lack of significant photons associated with the decay of S-35.
- 5. Thyroid counting of emitted gamma photons because all inhaled I-131 is assumed to be in the relatively transportable compound class D, and it is rapidly taken up into the blood and
deposited in the thyroid gland.

C. Four medical intervention techniques that are used to minimize internal dose include:

- 1. Removal of contamination to prevent internal contamination by washing of skin and wounds and possibly excision of contaminated tissue to prevent uptake into the blood.
- 2. Enhance excretion of contaminated body fluids to reduce deposition of radionuclides in systemic tissues. An example is the use of diuretics, e.g., increasing the intake of water to enhance the excretion of tritiated water from the body.
- 3. Use of blocking agents in the form of stable isotopes that compete for deposition sites in systemic tissues with the radioactive contaminant, e.g. KI to increase the deposition of stable iodine in the thyroid thereby blocking the deposition of radioactive I-131 and enhancing its excretion in the urine.
- 4. Use of chemical agents that form compounds with the radioactive contaminant that are excreted from the body, including chelation agents, e.g. calcium or zinc DPTA which form a complex with Pu-239 in the blood before the Pu-239 has a chance to deposit in the liver or bone. The chelated Pu-239 is then rapidly eliminated from the body with the urine.

D. Regarding physician’s recommendations:

- 1. I agree with the recommendation for chelation therapy following an inhalation intake of 5 ALI of Am-241 because all compound forms of americium are assumed to be in the intermediate transportable class W compound form, which is cleared from certain lung compartments with a half-life of 50 days or less to the blood. The committed bone dose of 250 rem thus can be lowered with very little risk from side effects of the chelation agent.
- 2. I agree with the lung lavage for 1 lung at a time following an inhalation intake of 10 ALI of mixed fission products provided the physician can state that the risk of the procedure is considerably less than the stochastic cancer mortality risk of about a 2.5% chance from a committed effective dose equivalent of 50 rem and provided the procedure is estimated to substantially reduce the radiation risk.

E. Specific medical interventions warranted by the estimated intakes of the radionuclides in each accident scenario 1 through 5 and any associated special concern and/or precaution are given respectively:

- 1. Washing of Pu-239 contaminated wound and excision of contaminated tissue: Concerns include disfigurement or enhanced uptake by using a poor procedure or technique, and precautions include monitoring of wound with a wound counter and the collection and radioactivity analysis of all washings and excised tissue to monitor the effectiveness of the procedure. Urine bioassay should be used to estimate the total uptake and internal radiation
dose for future medical guidance.

- 2. Increased fluid intake and physical activity to enhance excretion of tritiated water: Concern includes not to have such a high fluid intake that it could cause a significant electrolyte imbalance, and precaution includes daily sampling and analysis of urine samples to monitor the effectiveness of the procedure and to more accurately determine the total effective dose equivalent for future medical guidance.

- 3. Blocking agent such as Prussian blue (ferric ferrocyanide or one of its modifications) to limit the uptake of Cs-137 from the small intestine where it would otherwise have a fractional absorption ($f_1$) of unity: Concern includes the toxic effect of the blocking agent and precaution includes limiting the amount of the agent to limit its toxic effect. Once the upper respiratory tract and the GI tract have been cleared of Cs-137, the agent should no longer be used. Whole body counts should be obtained to estimate the internal radiation dose for future medical guidance.

- 4. Induce vomiting: Concern includes the need for its early implementation to limit uptake into the blood from the small intestine and precaution includes the collection and analysis of the vomit and of urine samples to determine its effectiveness and to estimate the internal radiation dose for future medical guidance.

- 5. Use of blocking agent KI (See C, 3 above.): Concern includes the early administration of the agent for it to be effective and precaution includes limiting the amount of the agent to amounts not likely to cause a toxic effect. Thyroid and whole body counts should be obtained to estimate the thyroid and whole body doses for future medical guidance.