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MALAYSIAN EXPERIENCES IN RADIOLOGICAL SAFETY ASSESSMENT ON NORM WASTES

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Abstract

Radiological Impact Assessments (RIAs) on proposed disposal sites for NORM wastes were performed in Malaysia. Analysis results were used to derive site specific guidelines for allowable residual concentrations of radionuclides in soil, calculation of doses and risks. Appropriate use scenarios and site specific parameters were used as much as possible so as to be realistic so that will reasonably ensure that individual dose limits and or constraints will be achieved. Disposals were performed to fulfil Atomic Energy Licensing Board of Malaysia (AELB) requirements for which the operator must carry out a radiological impact assessment. This is to demonstrate that no member of public will be exposed to more than 1 mSv/year from all activities. Fatal cancer risk factor is $5x10^{-2}$ per man.Sv. Radionuclides of main concern are radium-226 and radium-228 which are considered as toxic. Sensitivity and uncertainty analyses were performed to show that the parameters used as input into the computer model were justified so as to improve confidence of the public and the AELB in respect of the results of the analysis. Case study to determine a proposed near surface disposal site for treated oil sludge was described

1. INTRODUCTION

In Malaysia, any practice which involves the use of radioactive materials, is governed by the Atomic Energy Licensing Act 1984 [1] and its subsidiary legislation. The law is enforced by the Atomic Energy Licensing Board (AELB) which, besides the existing regulations established under the Act, also introduces various licensing requirements and conditions to ensure safe use of the materials in the country. There is a guideline called LEM/TEK/30 introduced by AELB on radiological protection requirements associated with activities involving NORM produced by oil industries. There is a section in this document that spells out details on the need to prepare a radiological impact assessment (RIA) before any disposal work can be carried out on the oil sludge waste. At present, this is the only guide available for reference for oil and gas industries when addressing issues related to disposal of NORM wastes or NORM contaminated wastes in Malaysia. Sludge farming is a common practice used as treatment of petroleum sludge to produce treated oil sludge, which is then disposed. According to the guidelines, for disposal purpose the operator shall be required to carry out RIA to all proposed disposals to demonstrate that no member of public will be exposed to more than 1 mSv/year from all activities. The proposed disposal sites needs to fulfil the requirements of the Atomic Energy Licensing Board before any operational work can be conducted.

In the RIA studies performed, the criteria used was 1 mSv/y for the individual member of the public as allowed by the BSS regulations[2] and 1 man.Sv for the collective dose of the overall population as used by the IAEA [3]. In the context of this study, *"members of the public"* is understood to mean representative individuals of the affected population group, which is expected to receive the highest level of radiation dose from the proposed NORM disposal activity. NORM, contained in crude oil, basically consisted of the whole series of uranium and thorium. Radionuclides, which are considered as source terms are Ra-226 and Ra-228 which, are primarily mobile and appear in oil sludge and scales [4].

2. ASSESSMENT OF DATA AND METHODOLOGY

Assessment was carried out by first identifying the radiological criteria issued by the Atomic Energy Licensing Board (AELB) and other relevant technical bodies including the International Atomic Energy Agency (IAEA) to be used as the basis and guide in the whole exercise. The criteria used were 1 mSv/y for the individual member of the public and 1 man.Sv for the collective dose of the overall population.

The next step is to identify the critical group or groups of the population who will be affected directly or indirectly by the radiological exposure from the near surface disposal site. The following step was to identify the source term and the scenarios through which various critical exposure pathways may occur, which may finally lead to a significant exposure received by the population. Based on several identified scenarios and exposure pathways, the most appropriate dosimetric model was developed and the amount of dose delivered was estimated. The estimated annual dose received by the population was then compared with the criteria mentioned above in order to determine feasibility of the site to be used as a disposal site.

From the analyses, site specific guidelines can be derived for allowable residual concentration of radionuclides in soil, calculation of risks and guidelines values. It can also be used to reduce residual radioactivity to levels that are as low as reasonably achievable. Appropriate use scenarios and site specific parameters must be used as much as possible so as to be realistic so that will reasonably ensure that individual dose limits and or constraints will be achieved. To build confidence with the AELB and the public, sensitivity and uncertainty analysis were conducted on every parameter especially data of parameters which are not site specific so that the uncertainty can be verified.

Scenario

Based on the immediate and long-term future development plan for areas around the disposal site for the treated oil sludge, three scenarios are being considered for an assessment. Scenario 1, which will take place in immediate future, where a proposed site will still be under the control of the operator, the relevant pathways considered are external gamma and inhalation (without radon). Scenario 2, which will take place after the scenario 1, where the site is redeveloped for industrial use, the relevant pathways considered are external gamma, inhalation (without radon) and radon. Lastly, scenario 3, where the site will be used as a residential area, the relevant pathways considered are external gamma, inhalation (without radon), meat ingestion, plant ingestion and radon. Based on the scenarios and critical groups identified above, the individual doses received by the groups resulting from disposal of the treated oil sludge to the proposed site were estimated for the three scenarios, respectively.

3. CASE STUDY: PROPOSED SITE FINAL DISPOSAL FOR NORM WASTES

Based on a case study performed on a proposed site using the methodology above, the maximum total doses expected to be received by workers and members of the public as a result of disposing the treated oil sludge to a proposed site are 0.05, 0.11 and 0.33 mSv/y for the scenario 1, 2 and 3 respectively. These estimated annual doses are found to be very well below (only 5%, 11% and 33% of) the individual dose limit used in the criteria i.e. 1 mSv. They are also found to be very much lower than the dose that members of the public generally received from natural sources which normally accounts to about 1 to 2 mSv per year. Figure 1, 2 and 3 shows the total doses from all radionuclides for the scenario 1, 2 and 3, respectively. The radionuclide that gives significant contribution to the total dose received is Ra-226. In term of collective dose to the population living on the site, it was estimated that for scenario 1, scenario 2 and scenario 3, the collective doses received were 0.003 man.Sv, 0.006 man.Sv and 0.20 man.Sv, respectively. Like the individual doses, these estimated doses also seem to fall within the acceptable collective dose limit of the criteria namely 1 man.Sv. Using fatal cancer risk factor of 5×10^{-2} per man.Sv [5] would then reveal the total excess cancer risk of 1×10^{-2} and 3×10^{-4} among members of the public and workers, respectively. The results indicate that the levels obtained were significantly below the required limits set by the AELB as quoted in the criteria. This implies that the proposed site is acceptable to be used as a disposal site for treated oil sludge produced by the operator.

4. CONCLUSION

Based on the findings of an assessment study, specific guidelines for the site can be derived for allowable residual concentrations of Ra-226 and Ra-228 radionuclides in soil. Results with levels significantly below the required limit set by the AELB criteria, a near surface disposal site once filled with the disposed material, can be released unconditionally without any requirement for future abatement and monitoring measures.

References

[1] Atomic Energy Licensing Act of Malaysia, Act 304, (1984).

[2] INTERNATIONAL ATOMIC ENERGY AGENCY, Radiation Protection, Basic Safety Standards Regulations (1988).

[3] INTERNATIONAL ATOMIC ENERGY AGENCY; Principles for the Exemption of Radiation Sources and Practices from Regulatory Control, IAEA Safety Guides, Safety Series No. 89, (1988).

[4] Weers A.W.Van, Pace I., Strand T., Lysebo I.,Watkins S., Sterker T., Meijne E.I.M., Butter K.R., Current Practice of Dealing with Natural Radioactivity from Oil and Gas Production in EU Member States, European Commission Report No. EUR 17621 EN (1997).

[5] A Manual for Implementing Residual Radioactive Material Guidelines using RESRAD, Environmental Assessment Division Argonne National Laboratory, ANL/EAD/LD-2, September (1993).