I Congresso Geral
de Energia Nuclear

Rio de Janeiro, 17 a 20 de Março de 1986

ANAIS - PROCEEDINGS

METHODOLOGIES FOR EVALUATION OF ENVIRONMENTAL CAPACITY AND IMPACT DUE TO RADIOACTIVE RELEASES, BY CRITICAL PATH ANALYSIS AND THEIR APPLICATION TO THE IPEN'S AQUATIC ENVIRONMENT AS A TYPICAL CASE STUDY.

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Abstract

A brief description of the tested concepts, for determination of environmental capacity and impact by critical path analysis technique and of dose limitation/optmization for radioactive releases is made. These concepts/methodologies are being applied in the environment of IPEN.

The aquatic environment of IPEN is dealt with in detail with a view to evaluate the possible critical paths, its capacity, and present and future radiological impacts.

Pinheiro canal whose flow(~70 m^3/s) is to and from because of the induced pumping at either end, flows majority of the times towards Billings reservoir with a transit time of about 15 h. The reservoir has about 1200.10^6 m^3 of water, surface area is $120.10^6 m^2$; residence time is about 100 d. Its discharge of about 75 m^3/s finally falls in the Santos Estuary (baixada Santista) and then to the open sea.

The present radioactive discharges are insignificant in view of the enormous dilution volumes available. The high dose of sewage and industrial pollution in this aquatic track shows its impact by the absence of commercial fish. Such activities are only recreational during week ends. Habit surveys in progress may conclude that critical pathways in future may be both external and internal.

The stable element analysis approach being applied to determine environmental capacity, concentration factors, intake and possible pathway of exposure, is expected to yield a lot of fruitful radioecological data of the IPEN's environment.

Introduction

The objective of IPEN is to avoid unacceptable risk to public and to its environment. Impacts(1) due to nuclear industry, as a whole, are controlled by the most advanced and rigorously implemented norms (2,3)of radiological protection. This may not be the case with other industries. This work deals with the aquatic environment and its pathways. The aquatic environment of IPEN is discussed with the objective to recommend the same methodology for studying the radioactive and other pollutants and their effects on man and the environment. The analysis of stable elements already occurring or liberated by other industries is of great importance because in many cases it offers a methodology to study the environment even before the radioactive releases are made. These are some of the points we wish to highlight first by reviewing some concepts of environmental capacity and impact evaluation by critical path analysis-CPA ,and then by giving brief reference to that CPA has been used successfully applied in various receiving aquatic environments of U.K., India etc. and that it is being applied in IPEN's environment also.

Environmental capacity-EC is the rate of introduction of radionuclides which at equilibrium will result in a rate of exposure per unit time in or from the critical material equal to that defined by the primary ICRP standard. A deliberate safety factor is introduced to take into account of uncertainties and thus,a lower provisional EC is defined. In setting such (authorized)[4] limits of discharge, rates of discharges are held as low as practical such that any deleterious effects should be held at the lowest levels which can resonably be achieved.

In case of other pollutants the acceptable levels to man and environment are unknown or poorly quantified. In this case, there is need to develop (5) methodsfor assessment of effects since without such information it is difficult to define any appropriate standard, inspite of the indiscriminately used and abused monitoring data. Provision of poorly quantified information is risky and can in turn lead to unfounded public alarm and establishment of unrealistic standards (e.g.for mercury in tuna fish). In absence of sufficient data on low concentration effects, the extrapolation from high exposures to zero effect at zero exposure,(as presently is the case with radiation)provides the basis for establishing control estimates/standards.Such estimates (both for radiologic and non-radiologic sources) should reflect caution and responsability to protect the environment but at the same time should not demand large and unrealistic margins of safety. Assuming that acceptable levels (primary standards) can be arrived, then next step in the assessment of impact is careful study of the environment i.e. radioecology/ecology and effect of pollutants. These studies establish acceptable rates of introduction, case by case, locality by locality.

Critical path analysis-CPA as used for waste disposal affords the best (2,4) developed example for environmental assessment. It is based on the study of all the complex pathways. There will be the critical path way, the control of which ensures more than adequate control of all other pathways. After full investigations of the ecosystem its use and habit surveys, critical materials are identified. The limiting EC is then set by comparison with the primary standard and on the basis of concentration in the critical materials per unit rate of introduction. When the objective is to control accumulation of undesirable pollutant in the environmental, the selection of critical material (i.e. in food chain) is easy, but where the question of stability of the ecosystem (i.e. avoiding point of no return) is concerned, substantial predischarge investigations may be required to establish the critical materials. The case of point of no return, the author feels, are the non-radiological loads, in Pinheiros canal, in parts of Billings reservoir and the baixada santista' region. Many environmental problems of this type have been arisen because of failure to recognize the necessity of pre-operational assessment.

Having established the type, quantity and rate of liberation of pollutant, next step is to derive a numerical relationship between rate of release to concentrations in the medium (air, water and soil) and then in the environmental materials. Derivation of these concentrations in the medium can normally be accomplished by use of simple dispersion models (tidal, river, ground water or Gaussian plume models for atmospheric releases). These simple models (6) will usually be sufficient to establish the order of radionuclide concentrations to be expected. Recourse to more complex models or use of tracer will only be needed if preliminary calculations suggest that the situation may be very limiting. The models are frequently used to evaluate impacts due to routine releases or accident conditions. The equilibrium concentration in environmental materials, other than initial concentrations in air, water and soil, are established by application of concentration factors. These concentration factors are well established for majority of the radionuclides/metal in wide range of environmental materials. More information is required on many other pollutants. Elemental distribution studies in man and his environment is a pre-requisite for evaluation of the acceptable limits of the contamination. The approach of analysis of stable elements distribution has been justified and tested- the approach in many cases provides environmental capacity, concentration factors, daily intake of elements and possible pathways of exposure (7). It has an added advantage that these studies can be carried out even prior to discharge of effluents. This approach is proposed to be used by us also.

By conducting habit surveys, critical paths, representative critical group of population are established. Rates of discharge may then be set so that the average exposure of this group does not exceed the primary standard. Regulatory authorities normally set discharge rates well below the limiting capacity. During provisional discharge, accuracy of the original assessment is checked through monitoring of the effluent and, where appropriate, through monitoring of the environment (8). Following discharges, and provided that a significant fraction of the provisional environment capacity is being utilized (>0.1%), environmental monitoring is conducted to confirm that radionuclide is behaving as predicted. Based on correlation of discharge rates of observed concentrations in critical materials, the initial assessment is revised periodically (this is one of the reason for the safety margin of 0.1%).

The above concepts/methodologies have been successfully applied in various receing environments of nuclear installations of various countries, principally of U.K.(9) and India (7). Their application to the study of aquatic environment of IPEN is promising as a typical case, because of the following: 1 - The study has potential to contribute further and strengthen the existing concepts, 2- Present radioactive discharges are insignificant, for future discharges large diluion volumes are available. 3 - The aquatic environmental is alarmingly loaded by nonradiological pollutants due to sewage and other industries. This makes it possible to apply stable element approach and also to compare radiological impacts in future with the impacts already created by nonradiological sources, 4-Discharge of Pinheiros canal is about 70 m^3/s. The transit time of radioactive-traced water mass up to Billings reservoir was about 15 hours (10) There is to and fro movement of the canal water mass because of induced pumping at either end. This is good from the point of view of added dilution/dispersion of radiological impact, if any, and subject of basic research from the point of view of nonradiological impact for those projects which might be attempted for recuperation of the ecology of this aquatic tract. The case of recuperation of Thames river in U.K. could be thought as good example. The water reservoirs of Guarapiranga and Billings are too large. Billings has about 1200.10^6 of water, surface area of 120.10^6 m^2 discharge of 75 m^3/s, residence time of 100 days(11) and finally, its water falls in the Santos (baixada santista) estuary and then to open sea, 5-Fortunately there are no fish in this aquatic track. This activity is only recreational. Detailed survey of the water use etc. and populational habits are underway and they may indicate that critical pathways in future may be both external as well as internal.

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Acknowledgement

All colleagues of Diretoria de Segurança Nuclear-N, have contributed through various discussions to elaborate the subject discussed herewith.