UP TO WHEN ALARA IS RELIABLE?

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ABSTRACT

The paper shows the principle problems introduced by ICRP publication 55 and provides suggestions to maximize the net benefit. The subject attacks six questions. 1- All options needed to maintain the net benefit positive. 2- The decision maker can define the optimum options by the premisses assumed. 3- The detriment of cost increases excessive when linear functions are not used. It is necessary to deal with the individual value of the protection and detriment costs. 5- The α value is excessively high. 6- For the same colletive dose, the preference to irradiate a large number of individuals at low doses rather than the contrary.

PROBLEM DEFINITIONS

The ICRP publication nº 37[1] which presents the calculation for the optimum analytical solution introduces the techniques of cost-effectiveness analysis, cost-benefit analysis, and extended cost-benefit analysis; this last technique makes the α value variable, that is the unit detriment cost of the collective dose.

The publication nº 55[2] introduces two more techniques, those of multi-attribute utility analysis and multi-criteria outranking analysis, giving leeway for decision taking techniques, relegating to the background the optimization as was up till then intended, that is, maximize the net benefit. This is very well demonstrated in the example of the ventilation system for a small uranium mine where it is shown that any of the first 4 techniques could be the optimum analytical solution based on the premisses adopted. It followed from the cost benefit analysis that the optimum option was nº 1. But when the qualitive manner of individual doses is introduced the optimum option becomes number 2 or 4. When the desconfort factor provoked by the ventilation is included the optimum option becomes number 3. In the extended cost-benefit analysis, considering the individual dose distribution factor, the optimum option returns to be number 3. In the multi-attribute utility analysis the optimum option could be number 3 or 4 depending on the importance given to the descomfort factor produced by the ventilation system. In the multi-criteria outranking analysis it is proven that and exclusion criterion of 0,5 presents two solutions, these being option 3 and 5 and that to eliminate option 5 it must be taken as exclusion criterion the value of 0,6.

This publication disesnagages a series of problems, six of which are made salient herein:

PROBLEM 1- The ICRP does not take the trouble to show that for not one of the 5 options does the benefit become B < O in proportion to the sum of protection costs, X, plus the increase in detriment cost, Y. This sum deviates from a factor of 3 for the same options to 2 between different options.

PROBLEM 2- Because as optimum analytical solution depends on the imposed conditions by the decision-maker, the graph of traditional optimization, figure nº 1, passes to that of figure nº 2.

PROBLEM 3- The linearity relationship between collective dose and detriment cost, so much, proclaimed in publication 22 [3], items 2,3,29 and 30 as well as in publication 26 [4], items 28 and 30 and in publication 55 [2] item 145, ceases to exist even through it is already considered to conservative. For this case the optimization graph becomes that shown in figure 3.

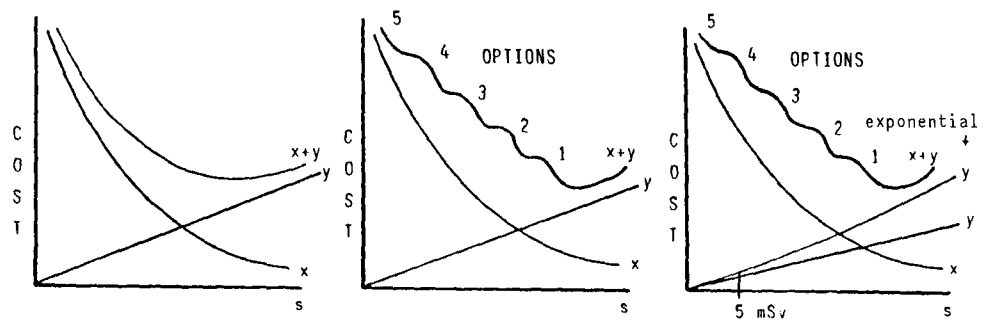

Fig. 1 - Traditional Optimization.
Fig. 2 - ICRP-Publication 55 - Proposed Optimization.
Fig. 3 - ICRP-Publication 55 - Proposed Optimization with Y Exponencial.

PROBLEM 4- We know that B is maximun when (X+Y) is at minimum but nothing is said in respect to each of these two last terms. In many countries these costs come from different sources and each has an interested to minimize expenses. On one side X is a real guaranteed imediate cost spent by executor of the service and Y is a probabilistic cost, not definite, with a long period of time for despenses. In agrrement with item 98 of ICRP publication 26 [4] the average life lost by a worker with radiation is uniquely 10 years and when it is necessary to lay out the money now foreseen probably the techniques for cures will have advanced and the cost declined. For example, some years ago carcenogenic breasts were removed which is not done any more; people died of thyroid cancer but now the thyroid is removed and the patient in saved, etc.

PROBLEM 5- The very high value of α is still more than that adopted by ICRP, with an average value for the world of 3 to 5 times higher than the real value as some specialists assert. In

this case the source who pays for the detriment estimates a cost from 6 to 10 times the real cost in detriment to the other source which evaluates real costs. This is contrary to that presented in many ICRP publications that dictate we be is realistic as possible is the evaluation of doses and consequen tely unfavorable to the detriment cost during the optimization calculation for the purpose to evade discarding. The use of ra diation in favor of another technique which offers higher risks but were move realistic in the calculations. Some publi- cations and respective items that assert the realistic condi- tion are: Publication 22[3], annex II, Publication 26[4], item 30, Publication 35[5], items 36 and 84, and Publication 55[2], items 38 and 55.

PROBLEM 6- The ICRP gives emphasis to the preference to irra- diate a maximun number of individuals in low dosage rather than a small number with high doses for identical colletive do ses. Since in both cases the doses for the optimization calcu- lation are below the annual limits and therefore inside the li near zone between dose, detriment, and biological effect, the emphasis should be the contrary.

For example: If 20.000 people were irradiated with a dose of 1 cSv having a probability of death of 4×10^{-4} cSv^{-1}, we can say 8 people die by dose effect. On the other side having 10.000 people irradiated with a dose of 2 cSv with the same probability of death we would have only 4 deaths by radiation. Conclusion, the probability of death increased by a factor of 2 bu the number of deaths decreased by a factor of 2.

RECOMMENDATIONS AND POSSIBLE SOLUTIONS

- For the first problem instigate the recognition of the calcu lation of B for the justification of the activity. With this calculation realized you can evaluated the maximun value of $(X+Y)_{max}$ which makes B=0 and this will constitute a second cons traint in addition to dose limits. Item 32 of Publication ICRP- 55 discusses the dividing line of B=0. We suggest therefore an ICRP publication with a practical guide for the calculation of the justification showing how other factors could be inserted in addition to those of economic and social.

- For the second problem it should be remenbered that the deci sion taken depends on the justification and not on optmization, and this subject is very well explained in items 32 and 33 of ICRP Publication 55. We urge therefore that the technical fac tors which enter into the calculation make themselves with their relative importance as partial parameters of the X and Y factors and that the sensibility study with its variation should be within tecnically justifiable intervals. We suggest a re-edition of ICRP Publication 55 with this eminent technical character and leave the decision which has no technical connota tion to those which have the authority.

- For the 3rd problem the ICRP should decide what is the most realistic relation in light of actual knowlege between dose, de

triment, and cost when the doses are below the limits and make this relation or relations valid of all cases. The detriment cost should be established by the competent authority of the country based on the ICRP recommendations. The relation or relations between those three parameters, having various bands of dosage, should be published by the ICRP with urgency.

- For the 4th problem we should take into account the pair X and Y and because of reasons put forward we suggest and evaluation of $X \cong y$ or $X < Y$ in addition to $(X+Y)_{min}$. The new edition of ICRP Publication 55 should attack this problem and manage to clarify it.

- For the 5th problem, since the distribution of doses varies in the different options; different values of α change the panorama of the optimum solution and therefore this value should be extremely realistic, even more so than of the proper dose, since that the interest is to encounter the differences between the options. Thus we suggest that the ICRP realizes an evaluation of the calculation for α and publish this as soon as possible. Excessively high values of α permit the choice of high risk techniques only due to the fact that we have excessively conservative numbers.

- For the 6th problem we suggest that the ICRP technically show if our example constitutes a sophism or not. In the negative case we eliminate from ICRP publication 55, since that all considered doses are below annual limits, the discussion with respect to a large number of individuals radiated with small doses or a small number radiated with doses higher for the same collective dose value.

REFERENCES

(1) ICRP Publication 37: "Cost-Benefit Analysis in the Optimization of Radiation Protection", 1983.

(2) ICRP Publication 55: "Optimization and Decision-Making in Radiological Protection", 1989.

(3) ICRP Publication 22: "Implications of Commission Recommendations that Doses be kept as Low as Readily Achievable",1973.

(4) ICRP Publication 26: "Recommendation of the ICRP", 1977.

(5) ICRP Publication 35: "General Principles of Monitoring for Radiation Protection of Workers", 1982.