INFLUENCE OF ALPHA VALUE IN THE OPTIMIZATION ANALYSIS FOR TRANSPORT SHIELDING OF FISSION PRODUCTS.

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Abstract.

In continuation of the paper "Optimization Analysis of Irradiated Targets Transport Shielding to be Used in 99Mo Production Plant" we study in this paper the sensibility of shielding thickness answer to the variation of alpha value. For that, we made a retrospective and projective calculus of alpha value related to the Gross Development Product - GDP and population of Brazil. This procedure, intends to verify the cost/person-Sv in the next thirty years which is estimated time of the life cycle of the shielding. We have considered three situations: Historic Realistic, Government Institution and Historic Optimistic. From this three curves we can see that till 2025 the alpha value in the best situation ranges US$ 5,000, then we considered the real alpha value and the official alpha value and we try to verify if there is an optimum shielding that attend all the cooling times considered. We found that 26 cm of shielding can be considered the optimum thickness for all the cooling situations.

1. Introduction.

In a near future a production plant of 99Mo from fission products will set be up in IPEN-CNEN/SP. The targets will be irradiated in IPEN's reactor IEA-R1 and transported to Processing Department Building. The targets consists of plates with an aluminum cladded uranium/aluminum alloy, 1,0g of uranium enriched to 93% in UAlx matrix, the dimension are 130 mm length, 35 mm width and 1,5 mm thickness.

In the paper "Optimization Analysis of Irradiated Targets Transport Shielding to be Used in 99Mo Production Plant"(1) was made an optimization analysis(2) of the shielding where till six irradiated targets will be arranged in side, one parallel to the other distant 5 mm. The final activity of 99Mo is expected to be 50 Ci for each target considering the time of cooling down and processing. The activities of the irradiated targets and dose distribution to different thickness of the shielding were determined using the computer codes ORIGEN II(3) and ISOSHLD(4).

To get the best yield of the process cooling down time cannot exceed 12,0 h. The thickness of the shielding was optimizes to the following transport time: 1,0; 2,0; 3,0; 4,0; 5,0 and 6,0 hours with the purpose to get the better tendency. In this case the time of cooling, before transport, range from 11 to 6 hours, so that total hours (transport + cooling)= 12.

The collective doses were determined related to São Paulo population density, were considered the distance up to a person did not receive 1% of the

annual public limit.(5) As a critic group were considered the driver and his auxiliary.

The transport will be made once in a week. The options to the radiological protection was obtained changing the shielding thickness in intervals to get the best thickness. In order to compare and verify the results consistency, the calculations were made through the analysis of efficiency-cost and benefit--cost.

For the optimization calculation was used a alpha value of US$ 10,000/person-Sv, adopted by our National Commission of Nuclear Energy(6) The work will also produce a conception design to the transport shielding appropriated to a functional handling, transport and transference of irradiated targets from the reactor swimming pool to the processing hot cells.

This shielding will attend the requirements to a package type B(7). The analytical solution in function of the decay period from 6 to 11 hours ranges from 22 to 28 cm of lead. All the collective dose remains below 1 person-Sv/year and the several critical group never range the dose of 100 mSv/y. In this case the Brazilian regulation exempts the application of the optimization principles. More details see the paper mentioned(6).

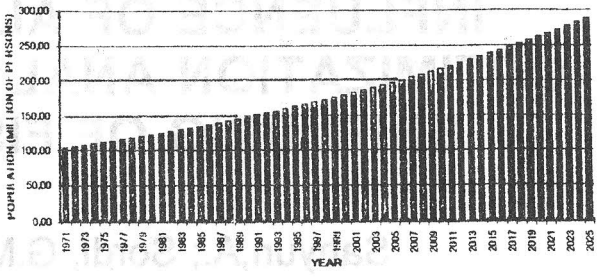
2. Basic Data.

In this paper we study the sensibility of shielding thickness answer to the variation of alpha value. For that, we made a retrospective and projective calculus of alpha value related to the GDP and population of Brazil(8).

This procedure, intends to verify the cost/person-Sv in the next thirty years which is estimated time of the life cycle of the shielding.

The population estimate until the year 2025 was obtained in an official government institution. Because of the economic and social instability of our country, the Instituto Brasileiro de Geografia e Estatística - IBGE published only the estimated GDP until 1995 and also has a gross estimate to its growing rate at the level of 1% a year. As we had past history data for GDP and population, we made calculations for alpha till 1971, time when the country was growing fastly. In figure 1, we show the population grow projected by IBGE and in figure 2, the alpha values. From this figure (curve 1 of figure 2), we can see two periods of alpha growing: one is the gold period that goes from 1971 to 1981 and another period with lower grow from 1981 to 1991.

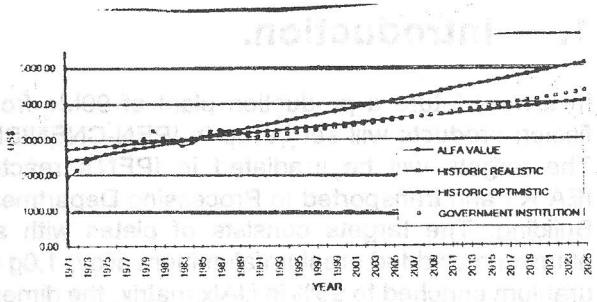
FIGURE 1
Population Grow Projected by IBGE



We task away the gold period, because it doesn't represent the real situation nowadays, but we use the percentual grow rate from 1981 to 1991 to project the results till the year 2025 (curve 2 of figure 2). We call this curve as "Realistic Historic Curve".

We made another projection using all the 21 years period and because of the gold period, we will call it "Optimistic Historical Curve" (curve 3 of figure 2).

At last, we built a third curve, based on an "ad-hoc" index given by IBGE, as being an approximate data, which can reach a growing rate of 1% in the per capita GDP (curve 4 of figure 2). We will call this curve as "Government Institution Growing (GIG)".



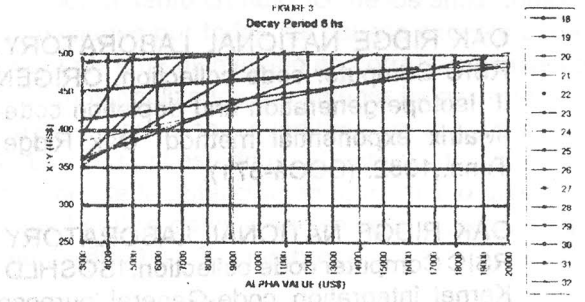
3. Results.

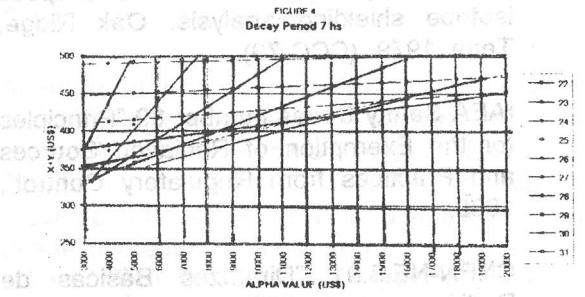
It's important to see that the GIG curve of 1% a year, gives an alpha value and, consequently, the GDP value, lower than the Historic Realistic, till the year 2008, and after that, it is bigger. But both of them are lower than the Historic Optimistic. In 2025

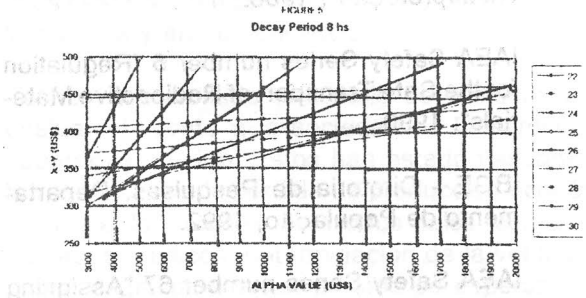
we would have the following value for alpha:

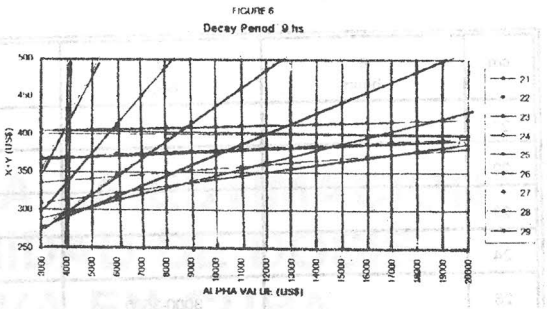
HIstoric Realistic	4050
Government Institution	4300
Historic Optimistic	5080

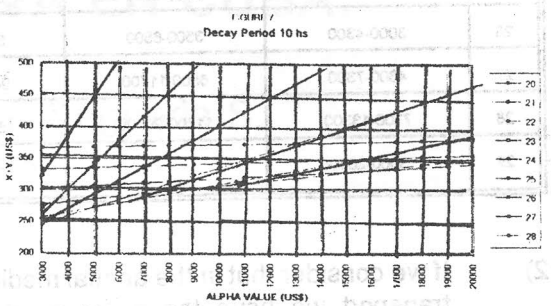
We can see that Brazil is far from the value adopted by developed countries, ground US$ 20,000/-person-Sv. We made calculations to verify which would be the GDP per capita grow per year, to reach in 2025 (next generation), the value of US$ 20,000/person-Sv which is, as already said, the value adopted by developed countries. The result is a GDP growing rate of 5,82% a year. We believe that this value is not part of the regular reality. Analyzing the minimum alpha value, calculated for our country and the minimum value suggested by IAEA(9) and the different projections considered for our country, we varied the alpha value from US$ 3,000/person-Sv to US$ 20,000/person-Sv.

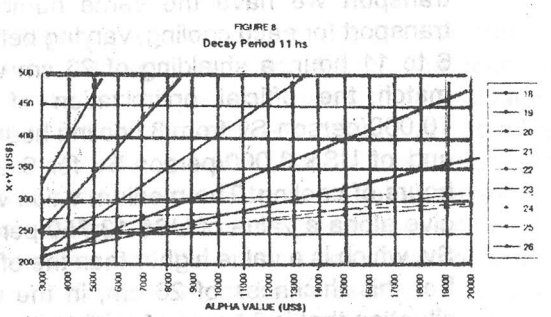












The result curves of interest for cooling from 6 to 11 hours, show the optimum ranges of alpha value for different shielding thickness (figure from 3 to 8).

To discuss the results, we built a table (Table 1) with the optimum ranges of alpha as a function of shielding thickness for 6 different cooling times.

The values above US$ 20,000/person-Sv were obtained from the projection of the own curves, once the doses in the critic group were lower of 10 mSv/year, value that is considered as zero by IAEA.

4. Conclusions.

From this table, we can verify that:

1) The results for the alpha value in our country and for the official value of US$10,000 /person-Sv, were put in table 2;

Table 1

cm	6 hours	7 hours	8 hours	9 hours	10 hours	11 hours
21						3000-3500
22						3500-6300
23					3000-5000	6300-11100
24				3000-5200	5000-9300	11100-21500
25		3000-3500	3000-5500	5200-8700	9300-15800	21500-46000
26	3000-4300	3500-6500	5500-9800	8700-17000	15800-20000	
27	4300-7300	6500-11700	9800-18500	17000-20000		
28	7300-13300	11700-20000	18500-20000			
29	13000-20000					

2) If we consider that in the annual medium of transport we have the same number of transport for each cooling, varying between 6 to 11 hour, a shielding of 26 cm would match the official optimization of US$ 10,000/person-Sv from 8 cooling hours up; and of US$ 3,000/person-Sv for 6 and 7 hours of cooling. The medium value would give alpha a value of US$ 13,750/person--Sv, which is a value higher than the official. For this thickness of 26 cm, in the worst situation that is 6 hours of cooling, the critic group would receive an annual dose of 0,414 mSv, that is lower than the public limit of 1mSv/year.

As a final conclusion, referring to last work's conclusion (e), here exposed: "From column 6, a shielding with 28 cm, is sufficient to include all of the optimized solution and in the bad case the increase on the protection cost near 75%, comparing with the optimized thickness for 11 hours cooling", we see that if we adopt this new philosophy, much wider, the saving compared to the last solution (28 cm) would be around 20% in the radiological protection cost. Of course, the final decision has to take in consideration political aspects of advantage or disadvantage to produce 99Mo in Brazil or to import from other country.

5. References.

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