Research Progress on Chinese α Value of Radiation Protection

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10/23/2019

Abstract

Based on the "reassessment of NRC’ s Dollar per Person-Rem Conversion Factor Policy" NUREG-1530, Revision 1, primarily for the latest international updates and advances in radiation protection alpha values, from regulatory applications of radiation protection alpha values, Including the estimation of the relevant parameters which affect its valuation, and the estimation method of α value and the basis of updating,The estimation principle and process of α value are analyzed, and reasonable and feasible suggestions are put forward to improve the value of α Application to provide theoretical basis.

Dollar Per Person-Rem Defined

Definition: This factor translates "radiological exposure to a monetary value and, as such,allows for direct comparison between the potential health and safety benefits and the costs of a proposed regulatory initiative." – 60 FR 65694.

- **In short, dollar per person-rem is the dollar-value of the health impact of radiation exposure.**

Background and History

The NRC first used a dollar per person-rem value in 1974 and 1975 for rulemaking that promulgated 10 CFR Part 50, Appendix I, which addressed routine emissions from nuclear power plants.

– The value set was $1,000 per person-rem. This is the only place in NRC regulations where a dollar per person-rem value is estimated.

• The $1,000 value was used in numerous regulatory applications until NUREG-1530 was published in 1995.

– NUREG-1530 recommended a value of $2,000 per person-rem.

• Recently, on case-by-case bases, NRC has used higher dollar per person-rem values, in addition to the $2,000 per person-rem value.

– For example, in the regulatory analysis performed for COMSECY-13-0030 incorporated a higher value of $4,000 per person-rem.

Background and History(continued)

In 2010, the NRC staff began conducting research to update the dollar per person-rem value.

- SECY-12-0110 indicated that the NRC staff would work to update guidance documents relating to cost-benefit analyses, including NUREG-1530. The Commission approved the staff recommendation in an SRM in 2013.
- Further discussion can be found in Enclosures 7 and 8 in SECY-12-0110.
- Implementation plan can be found in SECY-14-0002.

Calculating Dollar Per Person-Rem

How is dollar per person-rem calculated?

– The NRC multiplies a current VSL by a cancer risk coefficient

– NUREG-1530 multiplied a VSL of $3 million by a cancer risk coefficient of 7.0 x 10-4 per person-rem from ICRP 60. This approximates a dollar per person-rem value of $2,000.

– Currently, NUREG-1530 does not provide a method for adjusting this value into real dollars.

Proposed Changes(CHINA)

- Adopt new VSL and cancer risk coefficient.
- Adopt low and high CNY per person-rem values.
- Apply two significant figures in calculating CNY per person-rem instead of rounding to the nearest thousand CNY value.
- Adopt a methodology to maintain the CNY per person-rem conversion factor in current year CNY.
- Adopt Dose and Dose Rate Effectiveness Factor for high dose or high dose rate situations.

Value of a Statistical Life (NRC)

VSL concept used widely throughout the Federal government to monetize the health benefits of a safety regulation.

- **VSL is NOT a value placed on a human life, but a value that society would be willing to pay for reducing health risk.**
- **Example: if the annual risk of death is reduced by one in a million for each of two million people, that is "two statistical lives."**
  - **(i.e., 2 million people x 1/1,000,000 = 2).**
  - **VSL is the monetization of the risk reduction across this population**

Value of a Statistical Life

1) The relationship between life value and age does not necessarily have a fixed relationship of change, but is related to personal income and social security. The income elasticity of regions or countries with different income levels is quite different, and the income effect is difficult to make up for this defect.

2) The concept of life value in disaster economy is concerned with risk, WTP or WPA reflecting risk change, not the value of survival and death, nor the specific life and death of specific people. Life compensation cannot be used to determine death compensation standard. The compensation for accidental death in China's laws and regulations or judicial interpretation is often determined according to the income level, and the essence is the human capital law.

3) Life value research rarely uses the value of life to carry out cost-benefit analysis of public policies for disaster prevention and mitigation. In particular, there are few studies on the value of life in the context of natural disaster risks. There are three reasons for this: first, the risk data is difficult to obtain; second, because the spatial distribution of natural disaster risks is quite different; third, natural disaster risk is a public risk, which is difficult to pass. The means of market exchange are reduced.

Cancer Risk Coefficient (NRC)

NUREG-1530 uses the value from cancer risk coefficient value from ICRP 60, published in 1991, of 7.0 x 10-4 per person-rem.

- **ICRP 103, published in 2007, presents an updated cancer risk coefficient of 5.7 x 10-4 per person-rem.**
  - **As part of this revision of NUREG-1530, the NRC will propose adopting this updated value.**
  - **ICRP 103 states the decrease is mostly due to improved methods of calculating health risks and advances in understanding of mutational processes.**
  - **Based on cancer risks across seven Western and Asian populations.**
- **Measures total detriment from radiation exposure (i.e.,morbidity and mortality factors).**

Cancer Risk Coefficient (CHINA)

Danger due to unit dose exposure

- We surveyed twelve types of cancer
- in conclusion:
  - General public: $5*10^{-2}Sv^{-1}$
  - Occupational exposure: $4*10^{-2}Sv^{-1}$

Data sources: Pubmed

Dollar Person-Rem Value

VSL x cancer risk coefficient = dollar per person-rem.

- ($9 million) x (5.7 x 10-4 per person-rem) = $5,100 per person-rem.
  - This is NRC's proposed best estimate.
- For sensitivity analyses, NRC proposes to adopt low and high dollar per person-rem values.
  - The proposed low VSL value will be $5.3 million and the proposed high VSL value will be $13.2 million. Values are from the median of other Federal agency VSL estimates.
  - Cancer risk coefficient value remains as 5.7 x 10-4 per person-rem.
- NRC proposes adopting low and high values of dollar per person-rem, $3,000 and $7,500, respectively.

Two Significant Figures

NUREG-1530 currently rounds the dollar per person-rem factor to one significant figure.

– Actual calculated value is $2,100 per person-rem, but rounded down to $2,000 per person-rem.

• If NRC updated this value consistently, new values would only occur when the dollar per person-rem factor can be rounded up to the nearest significant figure.

– e.g., would increase from $2,500 to $3,000 due to rounding, but $2,400 would round down to $2,000.

• Using two significant figures will allow for more gradual changes to the factor.

Methodology for Keeping Factor Current

NRC proposed formula for keeping the dollar per person-rem factor current is:

– Current VSL = 2014 VSL x Inflation x Real Income Growth Income Elasticity

• Revised NUREG-1530 will provide a worksheet for staff to use to update the dollar per person-rem value.

– Formula will be used whenever the dollar per person-rem factor is used.

• Revisit every 5 years.

Inflation Data in CHINA(Algorithm one)

In terms of calculating inflation, it is still a simple and straightforward Fisher-style equation with Fisher's equation: MV=PTM is the currency in circulation, V is the currency turnover rate, T is the total volume of goods and services transactions T is GDP, M is understood as the broad money M2 V is hard to find (in the financially underdeveloped areas, it remains basically unchanged). After the two sides are simultaneously differentiated, after deducting the influence of the currency turnover rate, it can basically be determined: inflation rate = M2 growth rate - GDP growth rate

A	B	C	D	E	F	G	H	I	J	K
指标	2016年	2015年	2014年	2013年	2012年	2011年	2010年	2009年	2008年	2007年
国内生产总值指数	106.7	106.9	107.3	107.7	107.7	109.5	110.6	109.2	109.6	114.2
货币和准货币(M2)增长指数	111.3	113.3	112.2	113.6	113.8	113.6	119.7	127.7	117.8	116.7
存款准备金率变幅	-0.5	-3	0	0	-0.11	3.11	0.9	0	4.55	3.05
贷款基准利率	4.35	4.35	5.6	6	6	6.31	5.81	5.31	5.31	7.47
M2-GDP	4.6	6.4	4.9	5.9	6.1	4.1	9.1	18.5	8.2	2.5

Inflation Data in CHINA(Algorithm two)

The inflation rate algorithm can be found in Mankiw's Principles of Economics, Chapter 24:

(CPI for the previous year - CPI for the previous year) / CPI for the previous year multiplied by 100%

-According to the CPI data released by the National Bureau of Statistics for nearly ten years, the inflation is 152% in 10 years, and the inflation rate is 4.3%.

中国历年居民消费价格通货膨涨率(CPI增长率)

年份	中国通涨率
2017年	1.59%
2016年	2.0%
2015年	1.44%
2014年	2.0%
2013年	2.63%
2012年	2.64%
2011年	5.41%
2010年	3.33%
2009年	-0.7%
2008年	5.84%

Next Steps

(1) Improve the radiation protection emergency system of nuclear power including radioactive devices in China and related regulations and standards, and formulate the radiation protection alpha value in line with China's national conditions.

(2) From the perspective of the parameters affecting the alpha value, the VSL and cancer death risk rate data are updated year by year to maintain the timeliness and rationality of the alpha value.

(3) Based on the international and other national laws and regulations and updated calculation methods, combined with the national conditions, and at the same time investigate the real-time data released by the Land and Resources Bureau, the Ministry of Communications, the Ministry of Environmental Protection and other institutions, update and maintain the database of alpha values and related parameters.

THANKS!