Beyond Academia; An Argument for Clean Up to Background Levels to Minimize Property Stigma and Devaluation

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ABSTRACT

While the academic community focuses on a debate between regulated and risk-based analysis for determination of clean up levels following a release or other contamination event, little consideration is given to the long-term effects which may be equally injurious to the residents and property owner; property stigma and devaluation.

The lowering of property values after a release or contamination of the property may be attributed to several factors. These factors may include the requirement to disclose prior to sale any "environmental hazards including but not limited to... nuclear sources" on the Property Condition Disclosure Statement used by real estate agents and the stigma associated with property which still contains levels above natural background.

Several real estate experts have also argued that stigma value damage continues after clean up.

In addition, more than one legal case has resulted in tax rebates for property owners due to diminished value as a result of environmental damage. In the cases discussed, the property owner filed for tax rebates to the local taxing authority claiming the property is severely devalued due to the contaminants. Rulings in favor of the land owner may entitle the landowner to a rebate of taxes paid since the date of the incident resulting in the contamination. This has been successfully argued in asbestos contamination cases. The result can be significant financial losses and subsequent hardship for the taxing authority including county, State or local governments.

Additionally, a fundamental constitutional argument regarding the lack of "due process" in regulatory approval processes also results in loss of real property.

The EPA, in northern Florida was involved in an agreement to purchase homes located near a contaminated site, although the properties were not directly affected by the contaminants.

This paper will provide an analysis of clean up levels as they affect property value and the local real estate market. Using market analysis of communities affected by contaminants such as those surrounding Superfund sites and areas of radioactive releases, the authors will discuss and argue why clean up to natural background levels or purchase of properties may be reasonable consideration in the regulatory process.

Tradeoffs Between Post-Emergency Clean-up Levels and Costs Following a Severe Accident Release[1]

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INTRODUCTION

A severe accident at a nuclear power plant can potentially release a significant fraction of the core inventory of radionuclides to the environment. Radiation exposure of the affected population from this release can have both short-term consequences, such as radiation-induced early injuries and fatalities, and long-term consequences, such as latent cancers, through various exposure pathways. In the short-term, the important pathways are inhalation exposure due to breathing contaminated air, cloudshine exposure from the passage of the radioactive plume, and groundshine exposure from standing on ground contaminated by the deposition of radioactive material. Longer-term consequences are mainly due to three exposure pathways: inhalation exposure from the resuspension of deposited material, ingestion of contaminated food and water, and groundshine exposure from living on residually contaminated land.

Emergency protective actions mandated by Part 50 Title 10 of the Code of Federal Regulations, 10 CFR 50.47(a),[1] are meant to prevent or reduce short-term consequences. These actions include relocation or sheltering of the potentially exposed population downwind of the release. Long-term consequences can be reduced by: decontamination of land and buildings, banning the consumption of contaminated milk and other foodstuffs, prohibiting the production of crops or animal feed on contaminated farmland, or by permanently interdicting land that cannot be decontaminated within a certain time period in a cost-effective manner.

Each of these actions will lead to costs that have to be borne by society. The Protective Action Guidelines[2] (PAGs) of the Environmental Protection Agency (EPA) can be utilized to limit short-term plume exposures and ingestion exposures from contaminated food within a planning area around each reactor site However, there are no specific guidelines for projected long-term doses from groundshine or resuspension inhalation which are below the respective PAGs. Long-term health effects depend on the clean-up level, also called the "long term interdiction limit," i.e. the allowable level of long-term exposure of a potentially affected population expressed in terms of the projected dose to an individual over a certain time period from the long-term exposure pathways. Relaxation of the long-term interdiction limit (i.e., allowing a higher dose over a certain period of time) will lead to higher doses to the population and more latent cancers but will decrease the offsite costs since smaller amounts of property and food will have to be

[1]This work was performed under the auspices of the U.S. Nuclear Regulatory Commission.

condemned. Conversely, a more stringent long term interdiction limit (i.e., a lower level of dose over the same time period) will lead to smaller health effects but increase the offsite costs. Thus, the two measures of offsite consequences—health effects and offsite costs—are inversely related and a particular choice of an interdiction limit is, in effect, a trade-off between these two consequence measures.

This paper evaluates the trade-off for five nuclear power plants studied in the NUREG-1150 program.[3] Using the severe accident source terms at each plant, the MACCS[4] probabilistic consequence code was run to calculate the offsite (or clean-up) costs as a function of the clean-up level (or, equivalently, the long-term projected dose limit) at each plant site. If a monetary cost is ascribed to the health effects, through the choice of a monetary value for a life saved or latent cancer averted (generally called a statistical-value-of-life, SVOL), then the sum of the clean-up costs and the health costs will be a minimum at some clean-up level and this level can be considered optimal from the standpoint of minimizing the total costs. Such a minimum is presented below for the five NUREG-1150 plants (Grand Gulf, Peach Bottom, Sequoyah, Surry, and Zion) and its implications for post-emergency clean-up levels are discussed.

DISCUSSION

Bases of Calculations

Details of the calculations presented below have been described elsewhere[5]; the bases are summarized below. (1) Accident source terms were taken from the individual plant studies in the NUREG-1150 program. (2) Consequence calculations were performed using the MACCS code (Version 1.5.11.1). In performing the consequence calculations, the emergency response assumptions were the same as those assumed in the NUREG-1150 study. The long-term protective assumption used in NUREG-1150 were to interdict land which could give a projected dose to an individual via the groundshine and resuspension inhalation pathways of more than 4 rem in 5 years (2 rem in the first year and 0.5 rem per year for the next 4 years). Banning of contaminated food and interdiction of agricultural land for crop growing was based on FDA protective action guides for exposure from ingestion for the food groups and crops modeled in the MACCS code (representative of an average U. S. diet) To estimate the effect of varying long-term interdiction dose limits on offsite costs, latent fatalities, and population doses, we recalculated the consequences at each of the NUREG-1150 plants for the following limits: 3.5 rem in 5 years (0 7 rem or 700 millirem per year), 2.5 rem in 5 years (500 millirem per year) and 1.5 rem in 5 years (300 millirem per year). These calculations were performed for all of the source terms at each plant out to a distance of 50 miles.

For each source term, the MACCS code calculates distributions of the consequences based on Monte Carlo sampling from one year of site-specific hourly weather and wind direction data. Apart from the variability due to weather, there is a very large variation in the consequences arising from the different source terms at each plant due to differences in the release parameters such as magnitude (that is, fractions of the core inventory released), timing and energy. To obtain a single value of mean (averaged over weather) consequences which is representative of all of the source terms analyzed at each plant we constructed frequency-averaged mean consequences defined as follows. For any mean consequence, C_i, for a source term i, the frequency-averaged value $\bar{C}$ is

$$\bar{C} = \sum_{i=1}^{N} \lambda_i C_i \Bigg/ \sum_{i=1}^{N} \lambda_i$$

where λ_i is the frequency of source term i and N is the total number of source term groups. $\bar{C}$ can be understood as a frequency-averaged ***conditional*** mean consequence value, that is the mean value (averaged over weather) of the consequence conditional on the occurrence of the accident and weighted by the frequency of the accident.

Total Costs as a Function of Long-Term Interdiction Limit

The total cost of an accidental release can be expressed as the sum of the offsite protective action costs, OC(r), and the health-related costs, HRC. The offsite costs are calculated by the consequence code for each selected value of the long term interdiction limit, r (denoted in mrem/year). To monetize the health effects, early and latent fatalities, calculated by the consequence code, the health-related costs are expressed as:

$$HRC = EFC + LFC$$

where EFC = early fatality costs and LFC = latent fatality costs. The early fatality cost can be simply written as:

$$EFC = SVOL * EF$$

where EF is the number of early fatalities and $SVOL$ (\$) is the selected statistical value of life. The latent fatalities are a function of the long term interdiction limit r and have to be discounted to present value due to the latency period between the time of exposure and the induction of the cancer. Table 1 displays the risks and latency periods for various types of cancer due to radiation exposure. We can then write the (discounted) latent fatality costs as the product of SVOL and the number of latent cancers:

$$LFC(r) = SVOL * \sum_{j=1}^{N} \frac{LF_j(r)}{(1+d)^{l_j}}$$

where

$Lf_j(r)$ = number of latent fatalities due to cancer type j at the assumed interdiction limit r,
l_j = latency period of the jth type of cancer, (yrs)
d = discount rate, (%/yr)
N = number of cancer types, and
r = interdiction limit, (mrem/year)

The total cost, *TC*, of an accidental release can then be written as:

$$TC(r) = OC(r) + SVOL * \left\{ EF + \sum_{j=1}^{N} \frac{LF_j(r)}{(1+d)^{t_j}} \right\}$$

With the exception of the statistical value of life, SVOL, all the other quantities in the above equation are calculated by the consequence code. Estimates of the mean of SVOL from various public exposure and hazardous occupation risk studies are approximately $10 million (1990 $).

CONCLUSION

The total costs to 50 miles as a function of the interdiction limit, r, have been calculated for Grand Gulf, Peach Bottom, Sequoyah, Surry and Zion, respectively. Figure 1 shows the results for the Zion plant; the results for the other plants are very similar. As the interdiction limit is reduced, the offsite costs progressively increase while the population dose and latent cancers decrease. Ultimately, a law of diminishing returns should set in as the interdiction limit is reduced; the reduction in total dose (and thus the number of latent cancers) should get smaller as progressively larger costs of condemning land and property are incurred.

The curve for total costs in Figure 1 assumed an SVOL of $10 million and a discount rate of 7% per year.

For most of the plants, the minimum of the total cost curve for the chosen SVOL lies in the range of 500 to 700 mrem per year. In other words, for a SVOL of $10 million, which represents a mean across many different public risk studies, an interdiction limit of 500–700 mrem per year represents an optimum from the standpoint of minimizing the total costs. Lower values of avoided dose limits, for example down to 200 mrem per year, will be associated with a significantly higher value of SVOL, which would be out of line with risk allocation decisions in many other areas.

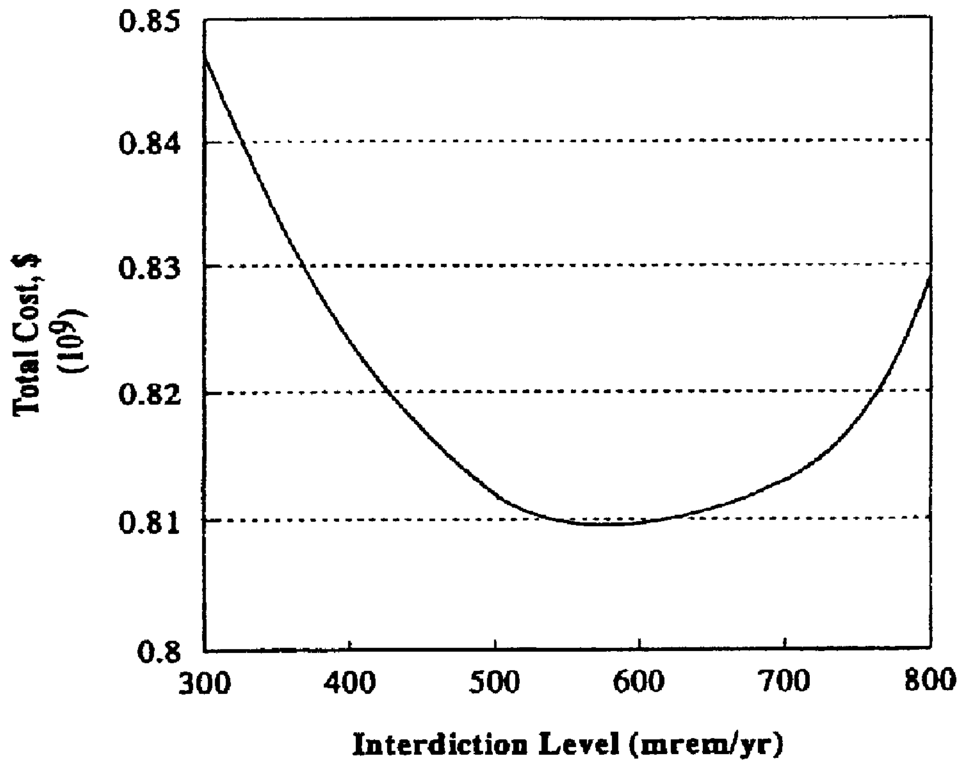

Figure 1 Total Cost at 50 Miles vs. Interdiction Level, Zion

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