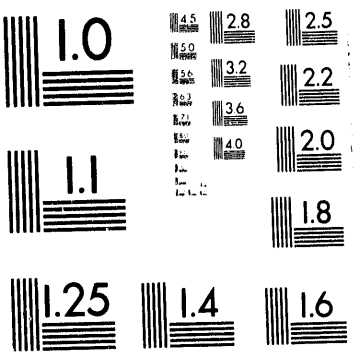
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# RISK ANALYSIS AND SOLVING THE NUCLEAR WASTE PROBLEM (U)

by

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# Risk Analysis and Solving the Nuclear Waste Siting Problem

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Views expressed are those of the author and not necessarily those of Westinghouse Savannah River Co. or the U.S. Department of Energy

**SUMMARY** In spite of millions of dollars and countless human resources being expended on finding nuclear wastes sites, the search has proved extremely difficult for the nuclear industry. This may be due to the approach followed, rather than inadequacies in research or funding. A new approach to the problem, the reverse Dutch auction, is suggested. It retains some of the useful elements of the present system, but it also adds new ones.

## 1 INTRODUCTION

Over the past decade, considerable effort, in terms of manpower and funds, has gone into estimating the hazards of existing or potential nuclear waste sites. The ultimate purpose, aside from meeting regulatory requirements, is to assure local residents that the risks are minimal, if indeed they exist at all. A wide variety of risk communications techniques have been suggested by social scientists and others to explain the results to non-scientists.

However, regardless of the specific techniques employed, the overall process often fails. For example, in a recent paper, Hinman et al (1) found that radioactive waste causes the second or third highest feelings of dread among members of both the Japanese and American publics. Hinman notes that radioactive waste ranks considerably higher than nuclear power per se on this scale. This result occurs after the expenditure of hundreds of millions of dollars to reduce risk from this source, with results reported in thousands of scientific papers and reports.

After studies are performed, potential waste site neighbors often become even more hostile than they were prior to the process. As has been pointed out by sociologists, the risk analysis itself is "captured" by facility opponents. These opponents point out that uncertainties exist in the computations and that zero risk cannot be guaranteed for any of the project phases.

Does this mean that risk analysis should not be applied in finding new waste sites or in evaluating old ones? Few would claim that risk analysis is not necessary, but it clearly is not adequate for producing social acceptance. In the context of waste siting, risk analysis has to carry too heavy a burden. While few risk analysts would claim explicitly that the field is sufficient to solve siting problems, the claims are implicit in the process. The Yucca Mountain controversy over high-level wastes is a case in point. While enormous amounts have been spent on various risk analyses over the years, there is little evidence that many Nevadan minds have been swayed. Indeed, the subject is little mentioned in public debates, except by opponents who note that the risk analyses always find a non-zero risk.

It is clear that other tools, not replacing but in addition to risk analysis, must be used to reach a successful conclusion to the decades-long process. Only in this way can the nuclear industry be freed from the albatross of nuclear wastes and go on to more productive activities.

## 2 A BRIEF HISTORY

Since the beginning of the nuclear era, it has been recognized that the wastes generated would pose a problem to public acceptance. It is sometimes believed that nuclear pioneers disregarded wastes and that they assumed a future generation could deal with it. The record suggests otherwise. For example, David Lilienthal, the first chair of the former U. S. Atomic Energy Commission (AEC), said in a book published four decades ago that unless the problem was solved, the industry would gradually diminish in public support. In the mid-50s, a sanitary engineer (2) from the AEC Reactor Development Division wrote,

> "One has only to consult the popular press to become acutely aware of the militant interest of the public in matters directly concerned with waste disposal and environmental sanitation..."

It is not clear when quantitative risk analysis for nuclear waste sites came into being. From the beginning, it was stressed by regulatory agencies that public health and safety would be protected in the siting and disposition process. By the mid and late 1970s, calculations were being performed, and some had a probabilistic aspect. Risk computations were performed around that time in the U.S. by the Environmental Protection Agency (3); the AEC (4), Science Applications Inc. (5), the U. S. Department of Energy (6), and the American Physical Society (7). Calculations were also performed in Sweden (8).

Inhaber (9) and others, in reviewing these studies, found that the waste risks, while non-zero, were a smaller component of total nuclear fuel cycle risk than any other aspect, such as mining or reactor operation. Since that time, many other reports have been issued, some in conjunction with the proposed characterization of a high-level waste site at Yucca Mountain in Nevada.

Waste risk studies have now been produced in many countries and with varying assumptions. None of them predict that the risk of nuclear wastes, when properly handled and disposed of either above-ground or in geological formations, would pose other than a minuscule threat to human health and safety.

## 3 DO RISK STUDIES HAVE ANY EFFECT ON THE PUBLIC?

Risk studies seem to have little effect on public attitudes, which is presumably the intended object of the studies. Surveys of the public in Nevada and elsewhere have indicated little knowledge of or even interest in these calculations.

Perhaps the most graphic example of this was seen during the Chicago convention of the American Nuclear Society in November 1992. A high official of the Department of Energy Office of Civilian Radioactive Waste Management (OCRWM) in Nevada was reviewing progress to date on characterization. He noted that all of the risk studies performed on behalf of his agency were available to the citizens of Nevada. Since OCRWM has made strenuous efforts in terms of public outreach, all of the reports noted in this paper and others issued since the 1970s would be supplied to anyone interested.

An individual in the audience then posed a question. Was the official aware of any Nevadan who had read one or more of these studies and then publicly stated that his or her opinion had been changed from anti-repository to pro-repository? The official was unable to supply the name of any such person.

This exchange suggests that while risk studies have been useful in meeting regulatory requirements, they have not, by themselves, generated much change in public opinion on these sites. The situation described above could be multiplied many times in experiences around the world.

## 4 THE PILING-ON OF RISK STUDIES

The risk studies situation is illustrated in Figure 1. In the first part, the dark sheets indicate the studies performed. Public opinion is generally unfavorable in spite of this work. Siting agencies then conclude that the solution is more studies, not a new approach. These studies are performed, and public opinion may shift slightly in favor of the proposed waste site. However, it is still a long way from overall approval.

Undaunted, the siting agency redoubles its efforts, as shown in the third part of Figure 1. More studies are produced, and public opinion is changed slightly. But the goal of general approval is still not reached.

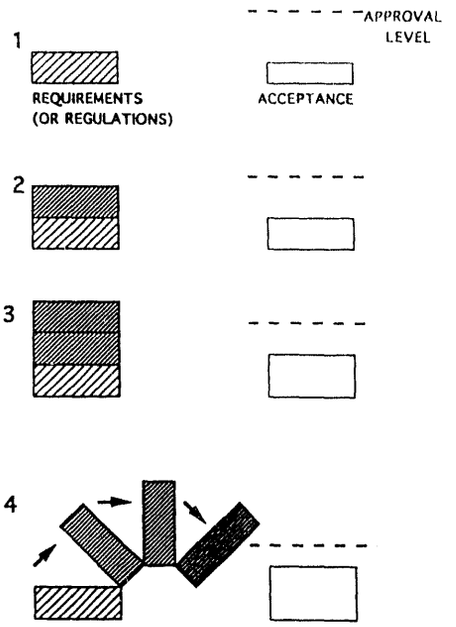


Figure 1. An analogy to the "overkill" of regulations designed to generate waste acceptance. The pile of requirements, shown on the left, continually mounts. However, the amount of public acceptance, as shown on the right, never gets to the dotted approval level. Finally, the requirements collapse of their own weight, and the process begins anew.

Finally, the process collapses of its own weight, as shown in the last part of Figure 1. After years - or in some cases, decades - of delay, the process - and the accumulated studies - are abandoned. The process begins again with new risk studies.

## 5 NEW TOOLS TO SOLVE THE PROBLEM

Some decision-makers are aware of the seemingly endless cycle of studies, more studies, abandonment and restart. They have searched for another tool to solve the problem. Some, such as the Decision Research group in Oregon (10), have proposed greater "trust" between risk analysts and the public. However, many of the proposed techniques to generate trust have been employed in the past, with few beneficial effects from the viewpoint of project sponsors.

For example, social scientists suggest that trust can be produced by having officials of a project readily accessible to any member of the public. This credo has been followed in the Yucca Mountain situation. The home phone number of the chief Department of Energy representative is listed in the phone book, available to any critic. Yet the level of opposition there remains strong, with all officials who have been elected state-wide for years being opposed to the Yucca Mountain project.

## 6 THE NEGOTIATOR APPROACH

Another approach, some distance from risk analysis itself, is that of a "negotiator." Community groups have often pointed out that the plethora of agencies concerned with siting have made it difficult for citizens to evaluate the facts. Congress, in the 1987 amendments to the Nuclear Waste Policy Act, provided for a federal negotiator for high-level wastes. David Leroy, former lieutenant governor of Idaho, was appointed to this position in 1990 (11). His tenure lasted until June, 1993.

In principle, a negotiator could reduce the conflicting signals often produced by the various bureaucracies However, the authority given the negotiator by law is unclear; his relationship to the Secretary of Energy and the head of the civilian high-level nuclear waste office remains cloudy (12).

From the viewpoint of risk analysis, it is instructive that the negotiator made little if any use of the extensive risk studies sponsored by regulatory agencies. He may have brought them to the attention of the counties and Indian tribes to whom he wrote, but they apparently played a negligible part in the discussions he held.

## 7 COMPENSATION - THE ULTIMATE TOOL?

To date, the amount of nuclear industry concern has been much greater for risk analysis than for any risk compensation to a potential community or state. The results suggest that the industry and the public might be better off if the proportion of concerns had been reversed.

Compensation has been a tool in siting. both in conjunction with and separate from risk analysis. Observers inside and outside the nuclear industry have said that communities should be fully compensated for the detriment caused by a waste site (13, 14), but until recently no methodology for setting the appropriate amount has been devised. In consequence, compensation amounts have been selected arbitrarily, leading to rejection by affected communities.

For example, in the case of Yucca Mountain, the original amount of compensation proposed in a Congressional committee in 1987 was $100 million annually. By the time the bill emerged from Congress, the amount was whittled down to $10 or $20 million annually, depending on the stage of construction. Whatever the level of funding, it was chosen without any apparent input by Nevada or Nevadans.

In a more recent case in France (15), a fee of about $10 million annually was to be paid to affected communities. However, as long as the fee amounts are set by outsiders and not the affected community, there will be a tendency to reject the amounts proffered. This took place in Nevada, and is on the way to happening in France.

## 8 AN AUSTRALIAN EXAMPLE

Because there is considerable land available in Australia for Locally Unwanted Land Uses (LULUs), there have not been riots such as have occurred over waste sites in the U.S., Korea and other Pacific Basin countries. However, recently one Australian example related to compensation did emerge (16).

Kakadu National Park is the site of large uranium deposits, worth perhaps $100 billion. According to some estimates, it is the richest uranium deposit in the world. The park is also the home of an Aboriginal population. Environmentalists oppose opening a mine there. Jean McSorley, Greenpeace Australia's nuclear energy expert, says, "It's sheer lunacy." However, Big Bill Neidjie, an Aboriginal spokesman, favors compensation to his people as the price for opening the mine. He says, "I would like houses which don't let in the rain. Most of all a schoolhouse."

This then is an example of how compensation, properly used, can satisfy those who will have to live with a site long after the legislation is passed and activities have gone onto other issues.

## 9 DIFFERENCES AMONG COMPENSATION SYSTEMS

It is evident that compensation systems have been treated as if they are all equal. However, there are as many types of compensation systems as there are varieties of risk analysis. Just as risk analysis must be carefully constructed to yield valid results, so a compensation scheme must be devised to achieve the goals of fairness and equity. In many instances, these twin goals can be reached only with adequate community control over the entire process. The present siting system, with or without compensation, offers little or no control to communities accepting wastes. The implicit assumption is that allowing this control would result in the facility being shut down or not constructed at all.

A number of solutions to the above-noted problems have been suggested. Kunreuther and others at the University of Pennsylvania (17) have proposed compensation-lottery systems, with the goals of ensuring equity and an open process. Others (18, 19, 20) have propounded auction-style systems, in which communities would, in effect, set the level of compensation they think adequate.

The reverse Dutch auction system of Inhaber is shown in the next two figures. Figure 2 shows the steps until the first (and probably only) bid is made; the latter traces subsequent steps. It is assumed that a state wishes to site a waste facility somewhere in its boundaries. Counties are relevant political jurisdictions. The principles can be applied to siting high-level waste, where the states would be the relevant political entities.

After announcement of risk and environmental ground rules, the siting authority gradually raises the bonus level.

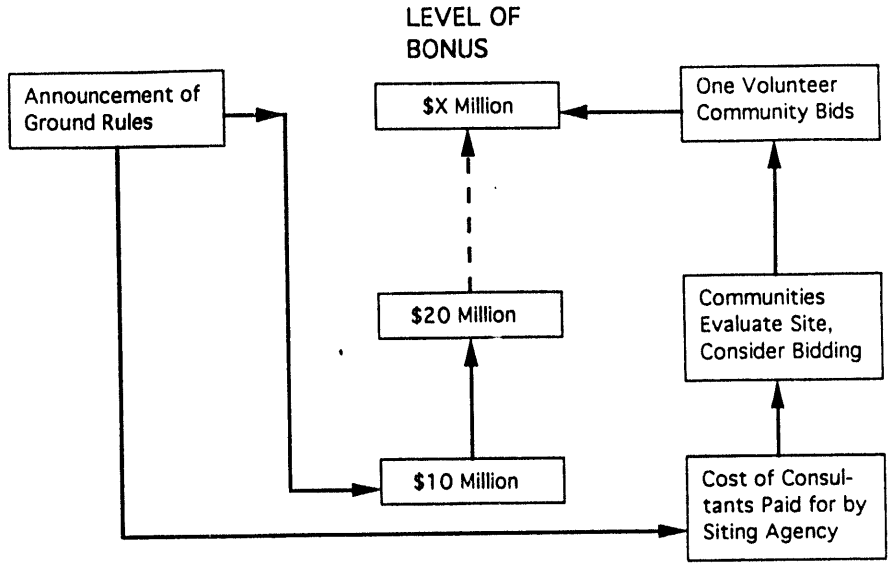


**Figure 2.** Pre-bid steps in the reverse Dutch auction for waste facilities. They begin with the announcement of the environmental criteria or ground rules. After each county (or other political jurisdiction) evaluates the regulations, the auction begins. The velocity of the bonus rise is set by the siting authority. As the price increases, a volunteer community will eventually bid.

The graph shows increments of $10 million, but other amounts can be used. Since communities often do not have the technical expertise to evaluate the complex criteria, they will be allowed to hire consultants at no cost to them to perform this task. Those who do are under no obligation to bid.

The bonus level rises until a community decides to make the first bid. At this point, the process transfers to Figure 3. The proposed site is considered by regulatory agencies. At the same time, most of the bonus - perhaps 2/3 - is paid into a trust fund. Many citizens will believe that, regardless of the safeguards, their community will not receive the bonus, but the trust fund will reassure them. If the site exceeds the criteria - even by a small amount - the process is completed and the total bonus is paid. If it does not, the auction continues, starting at the previous level. Eventually, a second community will come forward. The process is completed with the minimum number of complaints of unfairness and favoritism.

In the phrase used in geometrical proofs, risk analysis is regarded as necessary for siting, but not sufficient. In these new systems for siting, risk analysis is not abandoned but is no longer the sole driving force.

## 10 ADVANTAGES OF THE REVERSE DUTCH AUCTION (RDA)

The RDA has many advantages over the present system. This section outlines a few

(1) The correct monetary amount is paid to the affected community. While many bodies of legislation and regulations have pledged to pay an "appropriate" amount of compensation to the affected community, none of them specify exactly how the level will be reached. Some theorists, such as V. K. Smith (21), have discussed how that level might be computed, but there is no agreed-on methodology to reach conclusions. The RDA allows natural market forces to set the amount, rather than relying on closed-door negotiations or theoretical calculations.

(2) Data and decisions are decentralized. Under the present system, most data are kept far away from affected citizens, in the files of scientists or regulatory agencies. Under the RDA, the affected community will have access to as much data and/or interpretation as it wishes to digest.

(3) An end to "end runs" -- In the American system of football, an "end run" takes place when the ball is tossed to an outside players, who tries to go around the opposing team. This maneuver often occurs in the waste siting process, usually with unpleasant results. A community or even an individual is persuaded to lease or give his or her land to the siting authority. This is done without the concurrence of higher political jurisdictions, which have to give their approval. After this attempt at an end run, the well is poisoned, and the higher authority almost invariably says "no." Dozens of examples of this type could be given; the fiasco in the case of low-level waste in Illinois in the U.S. is a recent case. In it, proceedings dragged on for years when a small community could not get agreement from the surrounding county to go ahead.

(4) An end to ex post facto site selection -- In a number of nations, ex post facto reasoning has been used as an aid to site selection, This has tended to reduce public confidence in the entire procedure. For example, in Britain, sites that were selected decades ago for nuclear reactors were suddenly found to have many of the properties desirable for waste sites. But those who chose the sites in the 1940s never thought of them as ultimate repositories for wastes.

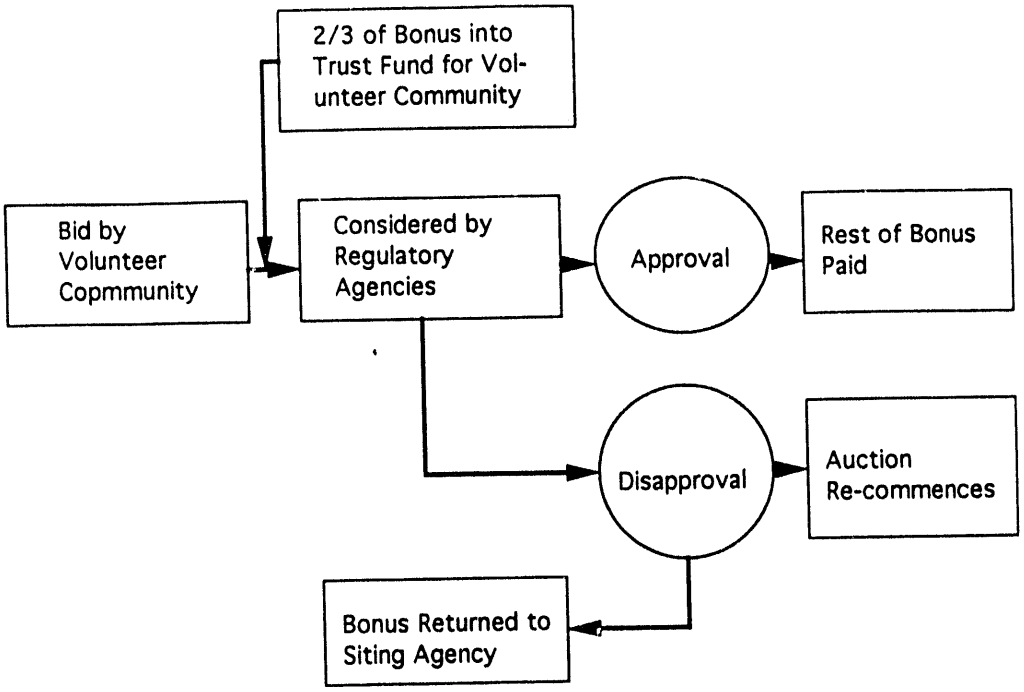


**Figure 3.** Post-bid steps in the reverse Dutch auction. After a bid is made, it must still pass environmental muster. The arrow to the right of the bid box shows that this is ensured. To produce confidence on the part of the bidding community that the bonus will indeed be paid in a timely manner, most of the funds are transferred to a temporary trust fund after the bid is made. If the proposed site meets the pre-announced environmental criteria, the total bonus is paid. If it does not, the auction begins again, starting at the bonus level previously achieved.

(5) Concentration on substance, not administration -- Administrative and procedural issues, which dwarf substance in the present system, should be substantially reduced with the institution of the RDA. The affected communities themselves, rather than a central siting authority, will set procedural requirements. Under the present system, the elaborate requirements are, in a sense, designed to convince affected communities that the risks are small. Under the RDA, they will convince themselves before any bid is made.

(6) End to closed-door meetings -- At present, many decisions impinging on the process are made behind closed doors. Although some lip-service is given to public meetings, these are often regarded by opponents as window dressing. The real decisions are often made prior to these meetings. Under the RDA, there would be no need for these types of meetings, which tend to bring the entire process into disrepute. Citizens will see a rising bonus, publicized in all the media. They can then decide to accept it or reject it. If they decide the latter, they need take no special steps, such as instituting litigation.

(7) Less complicated -- Much existing complexity has come about from attempts to be fair to all parties concerned. While some type of legal fairness may exist under the present system may exist, construction of the actual site seems to slip into the distance as the legal battles ensue. Under the RDA, each affected community will decide for itself what is fair and equitable. If it decides that the system itself or the size of the bonus is unfair, it will not bid. Since the major decisions are placed in the hands of the affected communities, there is much less need for a complicated - and ultimately futile - balancing of interests.

## 11 CONCLUSIONS

Ultimately, the approach of suggesting to citizens that they study and understand risk analyses may be fundamentally at odds with human nature. As a professor of history (22) has noted, the American Constitution was based in part on the philosophy of David Hume, a Scottish philosopher. Hume argued that the aim of government should not be to exhort citizens to attain grace or virtue. In the case of risk analysis, this state would be achieved by understanding its complex mathematics and elaborate assumptions. Rather, Hume's philosophy proceeded under the assumption that man is a pleasure-seeking creature, in pursuit of material gain. The reverse Dutch auction system outlined here would be instantly recognizable to him.

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