

## PUBLIC PERCEPTIONS OF HAZARDOUS TECHNOLOGIES & DEMOGRAPHIC POLITICAL INSTITUTIONS

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### ABSTRACT

Failure of a high level waste repository might impose high radiation doses on a few people, or very low doses on many people: no failure that has been identified can impose high doses on many people. Thus the public's perception of rad wastes posing a serious threat to human well-being is unjustified. Nevertheless, in open, Jeffersonian democracies such as the U.S.A., public concern has risen to a point where the future of waste disposal, and therefore of nuclear energy, is in jeopardy. A previous instance in which public fears bore little relation to objective dangers was the fear of witches in the Middle Ages. This fear subsided when the intellectual elite first became convinced that witches were not dangerous and then conveyed this conviction to the public. The waste dilemma similarly might be resolved if skeptical elites can be convinced that rad wastes, if properly handled, do not pose the threat commonly perceived by the public. This may require development of "inherently safe" packaging, such as the copper canisters adopted in Sweden.

Two contrasting views of the technology of nuclear energy, and particularly of nuclear wastes, coexist. I shall call these contrasting views the "expert's" views and the "skeptical public's" views. For the expert, nuclear energy is acceptably safe and desirable. By contrast a large fraction, if not a majority, of the American as well as Western European publics, regard nuclear energy as unacceptably dangerous and undesirable. Though a majority seems to regard nuclear as eventually being necessary, an equally large majority does not want nuclear installations, particularly waste disposal sites anywhere near them.

To be sure, the technical community at various times seems to have split on the issue of nuclear wastes. Most notable was James Conant's famous prediction, made in 1952 at the Golden Jubilee of the American Chemical Society's founding, that nuclear energy would turn out not to be "worth the candle because the disposal of waste products had presented gigantic problems--problems to be lived with for generations." Though skeptics within the technical community still raise objections to specific rad waste sites or practices, the technical consensus today rejects Conant's thesis: nuclear wastes can be sequestered with no chance of large numbers of people ever receiving a non-stochastic dose of radiation. (This contrasts with the experts' assessment of reactor safety: the probability of an accident in a reactor that will cause non-stochastic doses to many people--say 1 Sv or more--is around  $10^{-5}$  per reactor per year. The only scenario that I am aware of that leads to a non-stochastic dose from a high-level waste depository is one in which some future generation inadvertently directly breaches the depository or a contaminated aquifer in the vicinity of the repository, and in some way the radionuclides are ingested by individuals over a substantial period of time. This scenario I regard as extremely unlikely--say much less than  $10^{-5}$  per year. And even in this scenario, the number of individuals so exposed would be very small. I therefore conclude that the waste problem is not an insoluble

technical issue, contrary to what James Conant insisted 35 years ago.

Why then is the waste problem one of the Achilles' heels of nuclear energy? All of us in the nuclear community know that the first question asked of any nuclear proponent at a public meeting is "What about the nuclear wastes?" Why is the public's perception of the nuclear waste issue at such odds with the experts' perception?

I give two reasons: First, granted that a properly designed repository can almost certainly impose no non-stochastic dose on an individual, the bulk of the wastes generated by our military nuclear enterprise have not been sequestered in what would now be regarded as a properly designed depository. In hindsight, I now regard the worst mistake made by the old Atomic Energy Commission, to be its failure to solidify the Hanford & Savannah River wastes 25 years ago, and dispose of them in a geologic formation at the time. We could have done this had we realized how devastating our failure to do so would be. The efforts of the DOE to remedy these ancient shortcomings, coming at a time when things nuclear are in disfavor, exacerbates the public's fears and skepticism of all aspects of nuclear energy.

There is perhaps a deeper, psychological issue. In his book, *Nuclear Fears*,<sup>1</sup> Spencer Weart traces the history of the public's reaction to ionizing radiation beginning with Roentgen's discovery of x-rays. According to Weart, the public, informed by such articulate physicists and publicists as Fredric Soddy and H. G. Wells, right from the beginning acquired a twin perception of things nuclear: a benign new force that, as Wells said, would "Set the World Free;" and a demoniacal energy that would create a "Desert of Ashes." Thus ionizing radiation--unseen, unfelt, yet able to harm you, was particularly insidious. No matter that our natural background is  $10^{-3}$  Sv per year; no matter that at background levels no unequivocal health effects can be detected. A

1 Weart, Spencer (1988). *Nuclear Fears: A History of Images* (Cambridge: Harvard University Press).

perception of danger, even from well-sequestered wastes, captured the public, and this fear persists today.

The effect of low-level radiation on human beings seems to me to be the ultimate technical issue in connection with waste disposal. Unfortunately, it is the ultimate trans-scientific question. We shall never know whether a dose of  $10^{-3}$  Sv causes any deleterious effects on humans; in any event, the effects are so rare that they can properly be ignored. At issue is the validity of the linear hypothesis, a hypothesis that recent evidence from China surely calls into question<sup>1</sup>. In short, the public has become grossly hypochondriacal about the effects of low levels of radiation; and since this is, with any appreciable probability, the only level of radiation to which the public can be exposed from an engineered waste depository, the public has acquired what I would call a rad-waste phobia.

This is not the first time that the public has been beset by fears of unknown and horrible, yet undemonstrable, proportion. As William Clark pointed out some 10 years ago, the fear of witches in the 15th, 16th, and even 17th centuries has many similarities to today's fears of harm from low levels of radiation. The relation between deleterious effect and presumed cause can, in neither case, be demonstrated--yet the fear is so deeply ingrained that, in the case of witches, some million innocents were burned at the stake.

Cesare Marchetti<sup>2</sup> of IIASA has traced the rise and fall of the witch-phobia in 16th century Scotland (Fig. 1). As do so many phenomena, this followed an S-shaped logistic, with people coming to their senses and turning to other diversions than burning of witches after about 70 years. Of particular relevance is Trevor-Roper's<sup>3</sup> analysis of how the craze ended: "Third rank intellectuals and officials started saying that the craze was unjust and irrational.... Then came the intelligentsia, showing that what it said for two centuries was basically wrong... and that was the end of the process."<sup>3</sup> If this experience is relevant, one can predict that the rad-waste phobia might dissipate if only we wait.

But in the meantime much of the nuclear enterprise is disintegrating, though not at the same rate everywhere. Even though the public's fear of radiation is widespread, nuclear energy thrives in some of the liberal democracies, but it all but dead in others. Are there certain characteristics of a society's political institutions--the compact between those who are governed and those who govern--that somehow accounts for the success of nuclear energy in some places, and its seeming failure in others?

To address this question, Prof. John L. Campbell compares the history of nuclear power in France, Sweden, Germany, and the United States. France has had great success

and continues to pursue nuclear energy; the other countries have had successes that range from astonishing (Sweden) to good (Germany) to fair (United States), but now are experiencing nuclear moratoria, either de facto (U.S., possibly Germany) or de jure (Sweden). Certainly the United States needs nuclear power less than do these other countries. But this hardly explains why Sweden with no fossil fuel, has opted for a phase-out of nuclear power by 2010. Campbell argues that much of the explanation must be sought in the political structure.

I summarize Campbell's assessment of the political structures in the accompanying Table I. He characterizes the different countries with respect to how nuclear policy is formed, and how it is implemented--whether these activities are centralized or decentralized; whether unified, that is, confined to a single agency, or fragmented; and whether the process is closed or open to public participation.

TABLE I  
Institutional Features of French, Swedish,  
W. German, and U.S. Nuclear Energy Sectors

Country	Policy Formation	Policy Implementation
France	Centralized	Centralized
	Unified	Unified
	Closed	Closed
Sweden	Centralized	Centralized
	Unified	Unified
	Open	Closed
W. Germany	Centralized	Decentralized
	Unified	Fragmented
	Open	Open
U.S.A.	Centralized	Decentralized
	Fragmented	Fragmented
	Closed	Open

France stands out as the only country of the four in which both policy formation and implementation are closed to public participation--and it is the country where nuclear power, including waste disposal, has done best. All three of the other countries, where nuclear power is under heavy siege, encourage public participation, either at the stage of policy formation or implementation or both. These studies suggest that nuclear power, including waste disposal, prospers where the public is not given a chance to contest

- 1 The Chinese Study compared two communities, each involving about 900,000 person-years of exposure, one at a gamma background level of 0.115 Sv/year, the other, 0.340 Sv/year. The age-adjusted cancer mortality of the higher background population was found to be about 10% lower than for the lower background community--in short, there seemed to be a hormetic effect of radiation levels up to .34 Sv/year exposure. (Private communication from Chen Deqing, High Background Radiation Research Group, 2 Xinggang Street, Deshengmenwai, Peoples Republic of China.)
- 2 Marchetti, C. (1988). "On Society & Nuclear Energy. A Historical Analysis of the Interaction Between Society & Nuclear Technology with Examples Taken from Other Innovations." International Institute for Applied Systems Analysis, A-2361 Laxenburg, Austria.
- 3 Trevor-Roper, H.R. (1969). The European Witch Craze. New York: Harper & Row.

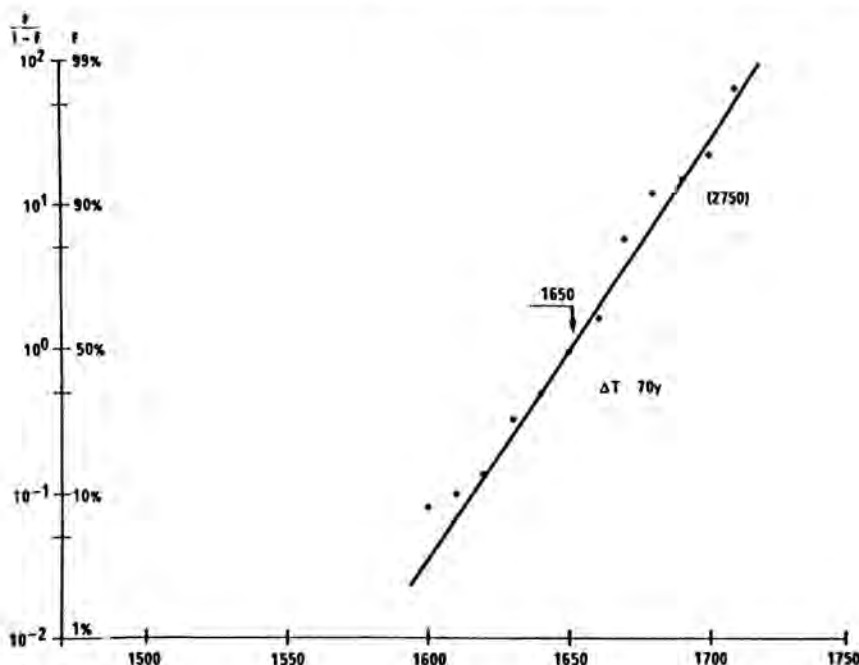


Fig. 1. Prosecutions for Witchcraft in Scotland in the Sixteenth to Eighteenth Centuries. Source: Clanner (1981), *The Enemies of God*.

decisions taken by the nuclear authorities. This point has been made by many other authors, particularly J. Barkenbus in his paper, "Nuclear Power and Government Structures: The Divergent Paths of the United States and France."<sup>1</sup>

I am not a political scientist and so I can claim no real knowledge of the origins of the different political structures that correlate nicely with the success or failure of nuclear energy. I did find in an essay on democracy in the 1957 edition of the *Encyclopedia Britannica*: "French democratic theory has consistently emphasized the right of the majority to rule without objection of a minority, and the French constitutions have reflected this view." I interpret this to mean that in France, the elected party formulates and implements policy, in this instance nuclear policy, with little regard for dissident minorities. In America, however, "The early fear of popular majorities has remained a hallmark of American democratic thought"--i.e., even the party in power is constrained by other foci of influence. I would call the French Democratic model Jacobin--insofar as the Jacobins were a closely organized center that seized power in the name of the majority; and the American model Jeffersonian--in that Jefferson upheld the tradition of the Federalist papers with their warnings against usurpation by the majority. Thus nuclear power does better in Jacobin--i.e. non-participatory democracies--less well in Jeffersonian, i.e. participatory democracies.

The American and German democracies are federal: a collection of more-or-less autonomous states always vying for power with the central government. The waste disposal issue stresses our Federalism since every state, indeed every

locality, has the inclination to invoke the doctrine of NIMBY, and has the power to block or at least delay the placement of a waste repository on land within its jurisdiction. On this account I find it not surprising that the original proposal to choose three sites for high-level wastes was aborted, and that Congress eventually ganged up on the least politically powerful state, Nevada. In this way a constitutional crisis was avoided--not because Nevada is a willing host, but because Nevada could not muster the political power, not to say, National Guardsmen, to block Yucca Mountain.

To summarize, waste disposal perceived as a hazardous technology by much of the public, shares with other hazardous technologies a basic dilemma: it seems to be incompatible with Jeffersonian--i.e., participatory democracies; and it places constitutional stresses upon federal democracies, or indeed, on federal systems of any kind. (I have in mind the decision by the Soviet government to cancel a reactor in Lithuania because of local opposition--an action unthinkable in the pre-Gorbachev era.)

Given that American democracy is Federal, Jeffersonian, and participatory, is there hope for restoring nuclear energy, including waste disposal to the favored position it occupied in, say, the 1960s? I remain optimistic for various reasons. First, with growing recognition of greenhouse, I should think that the public will generally become more convinced of the necessity for nuclear, and therefore more accepting of it. I say this realizing that some argue that conservation is a far superior path to salvation from greenhouse than is nuclear fission. To controvert this argument

1 Campbell, John L. 1988). *Collapse of an Industry: Nuclear Power & The Contradictions of U.S. Policy* (Ithaca: Cornell University); also J. Barkenbus (1984), *Nuclear Power & Government Structure: The Divergent Paths of the United States & France*, *Social Science Quarterly*, Vol. 65, No. 1, March 1984.

would take me too far afield: suffice to say that every path to salvation from greenhouse--conservation, replanting of trees, nuclear--will be needed; to reject any seems to be irresponsibly imprudent.

Second, if Marchetti is correct, we simply need wait and the low-level phobia will subside. Unfortunately we don't know how long it will take for these fears to decline--and we have to get on with the job.

Third, I am a strong believer in compensation. I therefore was most enthusiastic about Senator Bennett Johnson's amendment to NWPA which compensated the host state handsomely. I am disappointed that Congress seemed less generous than Senator Johnson--and I don't know whether the amount now in the till will assuage the Nevada officials who must stand for re-election. (I note that the City of Oak Ridge, in testimony before the MRS Commission, stated its willingness to accept MRS if compensation of about \$100 million for the state, and a third for Oak Ridge, was granted.)

All the above measures are important--but perhaps not the most important. I believe the main thrust of any attempt to revive nuclear energy--and this means achieving acceptance by the public--is to convince the skeptical elite of the correctness of what earlier I called the "experts" view of nuclear power: that it is acceptably safe and desirable, as well as being necessary. By the skeptical elite, I mean organizations such as the Union of Concerned Scientists, various environmental groups, influential science writers. After all, the public's fears of the nuclear demon were catalyzed by expressions of concern on the part of some scientists in the first place. Can we not reverse this image by converting this same skeptical elite, which would then convince the public through the organs of public information: mass media, schools, churches? Trevor-Roper's analysis of the waning of witchcraft may be relevant here: once the

intelligentsia was convinced of the foolishness of belief in witches, the witch phobia subsided.

How can we convince the skeptical elite? To my mind, by developing technologies that this elite finds acceptably safe. This seems to have been done in Sweden with its "certainly safe" thick copper canisters which apparently are now regarded as acceptable by the elite. As a result the Swedish waste program is proceeding with, as far as I can tell, very little public opposition.

What I am suggesting is that the waste disposal community adopt the same strategy that, willy-nilly, is emerging in the reactor community: to adopt systems that are transparently passively, even inherently safe. Rustom Roy's old suggestion--that the waste package itself be safe, and that one thereby depends only secondarily upon the geological barriers--seems to me to be good sense.

Are the presently proposed packaging methods for high-level wastes "inherently safe" in the sense I use the term? I cannot claim enough familiarity with the current canister designs to vouch for this, though I don't see why, if in Sweden the skeptical elites have been convinced by Swedish technologies, we cannot do as well in the United States.

Is there any chance of convincing the skeptical elites? A recent flyer from the Union of Concerned Scientists convinces me this is a possibility. For UCS, after a decade and a half of criticism of reactors as being unsafe, now concedes that inherently safe reactors may be possible and if they are in fact demonstrated, then nuclear could once more be part of the solution to greenhouse. I would hope UCS and other informed skeptics will adopt the same attitude toward the waste problem, and that this attitude will gradually seep into our mass media--I hope long before greenhouse has proven to the public that its rad-waste phobia has cost it dear indeed.