

FACTORS AFFECTING ACCEPTABILITY OF RADIOACTIVE METAL RECYCLING TO THE PUBLIC AND STAKEHOLDERS¹

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The perception of risk takes place within a cultural context that is affected by individual and societal values, risk information, personal experience, and the physical environment. Researchers have found that measures of "voluntariness of risk assumption," of "disaster potential," and of "benefit" are important in explaining risk acceptability (Fischhoff et al. 1979; Slovic et al. 1985; Starr 1969). A review of cross-cultural studies of risk perception and risk acceptance, as well as an informal stakeholder survey, are used to assess the public acceptability of radioactive scrap metal recycling.

ASSESSMENT OF RECYCLING ACCEPTABILITY TO THE PUBLIC

This section compares attitudes and behavior related to risk perception in Asia, Europe, and North America with the goal of identifying cultural and risk characteristics that affect risk acceptability. Public perceptions of radioactivity in consumer products have not been the focus of any studies, but have only been addressed peripherally. Therefore, likely public responses to radioactive scrap metal (RSM) recycling are inferred, in part, from more general studies of risk perception and acceptability of nuclear technologies and related activities.

The perception of risk takes place within a cultural context that is affected by individual and societal values, the availability of risk information, the nature of personal experience with risks, and characteristics of the physical environment. Thus, the perception of risk associated with any particular hazard is likely to differ among countries and also to vary within countries, especially countries with relatively heterogeneous populations and conditions. This section first discusses the main characteristics of hazards that appear to determine risk perception and risk acceptability. That discussion is followed with information on the cultural determinants of preferences for societal risk taking (e.g., a decision whether to recycle or to dispose of RSM).

Many studies have attempted to identify the specific characteristics of hazards that elicit a perception of risk on the part of the general public. Some measure of the probability of individual fatality is a common operational definition of "risk" in such studies. Researchers, employing a variety of approaches, have found that measures of "voluntariness

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of risk assumption," of "disaster potential," and of "benefit" are important in explaining risk perceptions.

Since about 1980, exploration of the cultural, historical, and political context of risk perception has been increasing. This research has focused on cultural patterns that are systematically linked to various issues, including perception of technological risks. On the basis of previous research, Dake (1991) related three major types of individual world views to respondents' concern with a broad range of contemporary issues, among them: "dangers associated with nuclear energy," "environmental pollution," and "dangers associated with technology." The three types of world views are the hierarchical, individualist, and egalitarian. Respect for authority characterizes the hierarchical world view, while the individualist is free-market oriented and supportive of self regulation. Egalitarians reject authority and espouse an equal sharing of an earth seen as fragile and finite.

Dake (1991) found distinctive patterns of concern with different types of issues, depending on whether individuals were characterized by a hierarchical, individualistic, or egalitarian world view. For the hierarchical and individualistic world views, levels of concern with perceived dangers of nuclear energy, pollution, and technology were low. For egalitarianism, in contrast, the levels of concern were moderately strong, especially relative to concern with other issues included in the survey. These findings imply that acceptance of risks associated with nuclear power, environmental pollution, and technology will be greater in societies oriented toward hierarchical social relations or individual self-determination than in societies with a strong egalitarian world view.

Cross-Cultural Comparison of Attitudes Toward Radioactivity

Because risk perception is culturally determined, differences in attitudes toward risk taking and toward the distribution of risk within society are to be expected among countries. These attitudes are affected by environment, experience, and education, both formal and informal. Countering the forces that create differences in risk perception, however, is the increasing worldwide influence of the media and the flow of information across national boundaries. Because of the need for cross-cultural communication regarding risks, several studies have been conducted to examine the cognitive structures involved in risk evaluation.

Table 1 presents key findings of five different studies that have employed the same methodology and basic questionnaire to assess risk perception by persons from different cultures. The original study was conducted by Slovic et al. in the United States in 1979 (and was replicated there in 1987). A comparable study in Hungary was reported by Englander et al. (1986), and results for a similar study in Norway are compared to the previous studies by Teigen et al. (1988). In addition, a similar study was conducted in France (Karpowicz-Lazreg and Mullet 1993), and a study using a subset of hazards from the original questionnaire was conducted in Hong Kong by Keown (1989).

In each study, college students were asked to rate a set of hazards according to the risk of dying faced by members of society as a whole due to each hazard. The scale extended from 0 (not risky) to 100 (extremely risky). Comparable items for the studies are summarized here. The mean risk rating for each hazard, the relative ranking of the hazards involving some form of radioactivity, and the overall mean rating for the 86 hazard types in these studies are shown in Table 1. The mean level of riskiness over all of the rated activities is considerably higher for the United States and French samples than for the others. Within the data ranges, the United States, French, and Hong Kongese ratings are relatively high for all of the hazards that involve some exposure to radioactivity. While this result indicates greater risk sensitivity in the United States and French populations and heightened perception of nuclear risks in particular, the risk rankings show a general consistency across all of the samples.

This body of research demonstrates that major similarities exist in nuclear-related attitudes between relatively well-educated United States and Asian populations and between United States and European populations. However, numerous differences also exist among cultures in the relative ranking of specific societal risks. These differences appear to be mainly due to differences in the environmental and cultural context of the countries studied. In general, the relative ranking of the subset of nuclear-related risks appears to be very similar.

Implications for RSM Recycling of Factors Affecting Risk Acceptability

In regard to public perception of risk, RSM recycling is at a disadvantage (compared with some other activities with equally low probability of causing harm) because of the stigma currently associated with nuclear weapons and nuclear power in most industrialized countries. This stigma has largely been avoided by the metals, petroleum, phosphate, and coal industries, all of which release substantial quantities of naturally occurring radionuclides to the environment. Thus, development of a broadly based RSM recycling process may be more acceptable to the public than one that solely or primarily serves the nuclear industry.

It is unlikely that any direct benefit from including radionuclides in metal products will be perceived and, certainly, none has been claimed. This situation is a major drawback for public acceptance of RSM recycling. In virtually all existing uses of radioactivity in consumer products there is no adequate substitute for the radioactivity in the functioning of the product. This has been one of the major premises for permitting such uses. In contrast, the main benefit of recycling RSM is the avoidance of environmental and health damages from replacing the metal. Since this benefit is an indirect one, it may render the recycling alternative less acceptable than if the benefit were direct.

Public acceptability of risk also depends on hazard characteristics, such as the probability of disaster and the voluntariness of participation in the activity leading to risk exposure. RSM recycling holds little potential for disaster because the levels of radioactivity involved would be very low and the radionuclides would primarily be bound into the metal.

TABLE 1 Comparative Risk Ratings^a and Rankings for Norwegian, American, Hungarian, French, and Hong Kongese Populations

Hazard	Norwegians		Americans		Hungarians		French		Hong Kongese	
	Rating	Rank	Rating	Rank	Rating	Rank	Rating	Rank	Rating	Rank ^b
Nuclear power	46.8	1	71.5	1	31.6	1	68.6	1	68	1
Radiation therapy	38.5	2	52.7	3	13.2	3	47.2	2	48	2
Chemical fertilizers	15.9	3	55.0	2	17.7	2	40.2	3	46	4
Sunbathing	15.7	4	19.7	6	11.0	4	32.3	5	27	5
Diagnostic X-rays	13.3	5	43.8	4	9.1	5	39.9	4	47	3
Fluorescent lights	11.8	6	21.5	5	8.0	6	22.6	6	— ^c	—
Mean risk (86 hazards)	27.2		39.7		20.9		40.4		NA ^d	

^a Average rating based on a risk scale of 0 (not risky) to 100 (extremely risky).

^b Rank out of a total of 30 hazards.

^c No data.

^d Not applicable.

Sources: Teigen et al. (1988); Karpowicz-Lazreg and Mullet (1993); Keown (1989).

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The resulting metal products would be as unlikely to cause a disaster as would the current global metal stock, which contains traces of naturally occurring uranium and thorium, traces of Co-60 from measurement devices used in steel production, and traces of fallout from nuclear weapons testing (Kuppers 1988). While disaster risks would be extremely low, assumption of the risks from metal exposure would be involuntary, as is the case for the present risks from radioactivity in metals. Unless the public is convinced that recycling is less risky than metal replacement, the involuntary nature of exposure is likely to cause public resistance to recycling.

The implications of the effects of cultural characteristics on risk acceptability are mixed in the case of RSM recycling. Recycling of RSM may be most acceptable in countries where a hierarchical world view predominates, because of a greater tendency in such cultures to trust assurances of process safety and to accept decision making by regulatory agencies. Egalitarian-oriented cultures are likely to be more concerned about pollution and opposed to nuclear power, but they are also likely to see conservation of resources as desirable and to be sensitive to the issue of environmental and health impacts in less-developed countries from mining ores to replace RSM.

Regardless of the overall cultural orientation in a given country, there is substantial variation in attitudes among individuals, and antinuclear activist organizations exist in many industrialized countries. Among the strategies employed by antinuclear organizations have been opposition to any release of radioactivity, no matter how small, and opposition to any waste reprocessing or disposal alternatives that would increase the viability of nuclear power. It seems likely that individuals who are committed to an antinuclear ideology would oppose RSM recycling as a means of expressing their opposition to nuclear power. Given the nature of such opposition, information regarding the relative risks of recycling versus replacing the metal resources is unlikely to influence antinuclear groups regarding the acceptability of RSM recycling.

In recent years, some segments of the public have developed the attitude that it is the government's responsibility to protect people from all involuntary risks. This "zero-risk" mentality is demonstrated in the demand for protection from pollutants, even at levels where initial statistical risks are negligible. It is also reflected in the detailed investigation of accidents to assess responsibility and to institute preventive measures, almost regardless of the cost. In such a cultural atmosphere of risk avoidance and denial of the pervasiveness of risk, the acceptability of RSM recycling is questionable.

RECYCLING ACCEPTABILITY TO STAKEHOLDER ORGANIZATIONS

The formal and informal positions of institutions and organizations with primary interests in the scrap metal market and in the political arena affecting RSM (hereafter

referred to as "stakeholder organizations") are summarized in this section. An understanding of the basis for these positions and the degree to which such groups may be willing to consider risk and cost trade-offs between recycling and disposal will provide a basis for policy development.

Identification of Stakeholder Organizations

As shown in Table 2, the stakeholder organizations involved in the issue of acceptability of recycling RSM include groups concerned with general environmental and specific nuclear safety issues; trade unions whose members would be physically involved in RSM recycling or in the production of goods containing RSM; and industry trade associations that represent nonnuclear industries involved in or affected by RSM recycling. Each of these various groups has a different position that reflects the specific interests and needs of that group's constituent members.

Environmental and related groups that have expressed opinions regarding RSM recycling are largely issue-oriented advocacy organizations that derive support from the general public. These include antinuclear groups organized as part of Public Citizen, the Natural Resources Defense Council, and Greenpeace. Also interested are the dozens of local environmental and antinuclear citizen groups that have been organized around specific site or regional pollution issues. These regional and local groups are diverse, numerous, and (generally) volunteer organizations. The regional and local groups were not surveyed as part of this study, although many of them interact with the U.S. Department of Energy regarding nuclear issues.

Several trade unions have a direct interest in RSM recycling issues. Workers involved in the smelting of iron and other metals, represented by the United Steelworkers, have a direct stake in RSM recycling because it may create new job opportunities. The Oil, Chemical, and Atomic Workers Union has a stake because of the potential involvement of atomic workers in RSM recycling. Of all of the unions, it appears that the Sheet Metal Workers Union is the most actively involved in nuclear waste issues, with a functioning joint labor-management committee on hazardous and nuclear waste.

Industry representatives with a direct interest and role in RSM recycling include those directly involved in the smelting and manufacture of metals, such as the Aluminum Association and the Iron and Steel Institute, and the scrap and recycling industries represented by the Institute of Scrap Recycling Industries. Significant interest has also been voiced by the oil and gas industry, which has specific interests in recycling drill pipe and other oil-field materials that become contaminated with naturally occurring radioactive materials (NORM).

TABLE 2 Stakeholder Organizations Responding to RSM Recycling Questionnaire

Organization	Major Focus
Environmental Groups (5) ^a	General environmental advocacy Nuclear-specific interest groups
Trade Unions (laborers) (1)	Direct involvement in RSM recycling (handle RSM) Indirect contact with RSM (manufacture products)
Industry Trade Associations (5)	Metals and mining Scrap and recycling Oil and gas production

^a Number of groups responding to survey questionnaire.

Survey of Positions of Stakeholder Organizations

To understand and compare the positions of these different groups, we identified and surveyed some representative organizations. The survey form was designed and tested to encourage detailed responses to key questions, as well as to encourage expression of a full range of concerns related to RSM recycling. The survey solicited the following information:

1. position on proposed U.S. Nuclear Regulatory Commission regulations designating radioactivity levels "below regulatory concern" (BRC);
2. position on RSM recycling and the rationale for that position;
3. major concerns with RSM recycling;
4. position on trace radiation levels as a factor in supporting/opposing RSM recycling; and
5. evaluation of the trade-offs between RSM recycling and disposal.

The groups' positions on these issues reflect a range of opinions, perceptions, and attitudes towards RSM recycling. Many of these responses are specific to each type of group and represent the types of concerns identified with the group's members or constituents.

The positions of environmental groups on RSM recycling generally reflect skepticism about RSM recycling. Antinuclear groups constitute a core of opposition to all forms of RSM recycling, which they characterize as a form of deregulation of radioactive

waste. At their extreme, these groups argue that "no level of ionizing radiation is safe." Several general environmental groups appear to take a somewhat more flexible position. While not stating its position on RSM recycling unequivocally, one recognized the need to set residual radioactivity standards for site cleanups and has urged that the U.S. Environmental Protection Agency be given more authority to set and enforce such standards. Other general environmental organizations, although not of the stature of the national membership groups, also appear open-minded about RSM recycling, "provided that adequate safety standards are met."

In general, labor unions accept the need to recycle RSM and support some form of recycling "as a sound environmental approach." While they have an overriding interest in ensuring worker safety, the unions also have an interest in job creation and market growth. Since RSM recycling represents a potential growth sector for some unions, they may favor RSM recycling as long as it can be demonstrated that worker exposure is minimized. In a political context, the unions interested in this issue could provide important middle ground between the positions of environmental groups and those favoring RSM recycling in some form.

Industry trade associations and their individual members hold a broad range of positions on RSM recycling. On one extreme, the Aluminum Association strongly opposes RSM recycling and regularly advises its members to avoid all contaminated shipments. The Aluminum Association is concerned that RSM recycling will contaminate the recycling waste stream and also create confusion and fear on the part of consumers. However, at least one large member of the Aluminum Association has expressed conditional acceptance of RSM recycling, but with a list of detailed concerns.

Nearly all other industry groups surveyed support some form of RSM recycling, although for varied reasons. The Iron and Steel Institute did not have a clear position on RSM recycling, but stated that "for certain product lines, some small amounts of low-level radioactive material may be acceptable." The most active industry group supporting some form of RSM recycling is the Institute of Scrap Recycling Industries. It is recommending new U.S. Nuclear Regulatory Commission regulations to permit the recycling of RSM, including, but not limited to, NORM-contaminated scrap. The oil industry, and especially its representative the American Petroleum Institute, also has strong interest in recycling NORM-contaminated RSM. Some major petroleum companies with NORM-contaminated scrap problems are considering establishing large-scale oil-field smelting operations.

Major Concerns of Stakeholder Organizations

Each major organization's position on RSM recycling summarized above is based upon specific concerns that reflect the interests of the group's members. These concerns can

be divided into several categories: liability, control of health/safety risks, and other concerns. Clearly, however, several specific concerns identified below fall into more than one category. It is important to note that all of the concerns expressed would be addressed in the normal course of the regulatory process.

Liability Concerns. Concerns with liability were not common, possibly as a result of a general lack of attention given to the RSM recycling issue by major industry groups. One environmental group voiced concern about "abuses of unverifiable, irretrievable contamination," which may indicate a general concern for accountability and liability issues.

Health/Safety Concerns. Nearly all respondents expressed concerns about health and safety risks associated with RSM recycling and agreed on the need to ensure adequate safety standards and controls. Environmental groups, especially the major opponents of BRC regulations, voiced strong concerns about "unnecessary exposures to unconsenting people," and "the damage to human health caused by exposure to radiation." From the perspective of these groups, environmental impacts associated with RSM recycling make it undesirable.

The Sheet Metal Workers expressed detailed concerns relating to worker health and safety, including the need for material documentation, worker training, safety inspections, and proper disposal of residuals. The Iron and Steel Institute also expressed concern about specific health and safety-related issues: contamination of metals for product uses that may result in human exposure; contamination of melt shop operations; the need for pollution control facilities; disposal/hauling problems; and introduction of the more dangerous isotopes.

Oil Industry Concerns. At least one major oil company with significant amounts of NORM-contaminated drill pipe has studied the issues and problems associated with RSM recycling in detail. Among the major findings presented by a recent oil industry study (Dehmel et al. 1992) are the following:

- Given the evolving regulatory climate, oil industry practices have shifted away from conventional land disposal to decontamination and storage.
- A comprehensive recycling program is needed in order to convince the scrap recycling industry and regulatory agencies that recycling can be both viable and safe. Such a program must ensure the protection of the workers, general public, and the environment.

Other Concerns. Several environmental groups and one industry group expressed concern that RSM recycling would harm conventional recycling programs by bringing confusion and fear into existing programs. In addition, oil industry representatives and the Institute of Scrap Recycling Industries, two of the most informed supporters of RSM

recycling, point to the need for a massive education and public relations campaign to improve public acceptance. As a key participant in any RSM recycling scenario, the Institute of Scrap Recycling Industries in particular has expressed additional concerns regarding the problem of sealed radioactive sources entering the recycling stream and the associated costs of removal and disposal. The Institute is also concerned about NORM-contaminated scrap that is sufficiently radioactive to trigger radiation detection monitors but is unregulated in all but a few states.

Evaluation of Trade-Offs by Stakeholder Organizations

Several groups (including industry trade associations and trade unions) recognized the benefits of RSM recycling compared with disposal and replacement. A representative response from these groups was: "To the extent that recycling can be achieved while protecting human health and the environment, we support this approach. Disposal is a finite method with potential harm to health for many years if accidentally disturbed." One group reserved judgment on the trade-off question, without knowing specific details of the alternatives.

The major exception is the strong resistance of environmental and antinuclear groups to any alternative that causes radiation exposure. Typical of this position are comments such as these: "The only good solution is to stop generating the hazardous substance. Pollution prevention is the only successful means of environmental protection." "Isolate the waste from the environment and people." Others expressed a view that balanced the inherent benefits of recycling with health and safety concerns: "Because reuse of scrap would present greater potential for exposure, adequate safety data and standards would become more essential."

The survey results indicate that the trade-offs between recycling and disposal have not generally been recognized or understood by the stakeholder organizations. Because of the critical importance of alternatives to RSM recycling, a good starting point for future study and education may be this particular issue of trade-offs between proposed alternatives.

CONCLUSIONS

Cultural and risk characteristics that affect risk acceptability were identified from studies of risk perception in Asia, Europe, and the United States. While there are numerous differences among countries in the relative ranking of specific risks, the relative ranking of various types of nuclear-related risks appears very similar. In regard to public acceptability, RSM recycling is at a disadvantage because of the stigma currently associated with nuclear weapons and nuclear power. This stigma has largely been avoided by the metals, petroleum, phosphate, and coal industries, which release substantial quantities of naturally occurring

radionuclides to the environment (United Nations 1993). Thus, development of a broadly based RSM recycling process may be more acceptable to the public than one that solely, or primarily, serves the nuclear industry.

The lack of any direct benefit from including radionuclides in metal products is a major drawback for public acceptance of RSM recycling. The main benefit of recycling is the avoidance of environmental and health damages from disposing of and replacing the metal. Since this benefit is an indirect one, it may render recycling less acceptable than if the benefit were direct. Public acceptability of risk also depends on hazard characteristics, such as the probability of disaster and the voluntariness of participation in the activity leading to risk exposure. Though disaster risks would be extremely low, assumption of the risks from metal exposure would be involuntary. Unless the public is convinced that recycling is beneficial, the involuntary nature of exposure is likely to cause public resistance to recycling.

Concerns of representative stakeholders can be divided into several categories: liability, control of health/safety risks, and other concerns. All of the concerns expressed would be addressed in the normal course of the regulatory process for recycling. With one major exception, stakeholders recognized the benefits of RSM recycling compared with disposal and replacement. The exception is the strong resistance of environmental and antinuclear groups to actions that cause radiation exposure.

For public acceptance of RSM recycling, perceptions of the overall risks and benefits of recycling versus disposal and replacement are of paramount importance. Recognition that there are no "zero-risk" alternatives is essential. Stakeholders and the public must to be sufficiently informed about the alternatives to evaluate the risk/benefit trade-offs.

REFERENCES

- Dake, K., 1991, "Orienting Dispositions in the Perception of Risk," *Journal of Cross Cultural Psychology* 22(1):61-82.
- Dehmel, J.-C., et al., 1992, *Scrap Metal Recycling of NORM Contaminated Petroleum Equipment*, prepared by S. Cohen & Associates, McLean, Va., T.P. McNulty and Associates, Evergreen, Colo., and Hazen Research Inc., Golden, Colo., for Petroleum Environmental Research Forum, Ponca City, Okla., Sept.

Englander, T., et al., 1986, "A Comparative Analysis of Risk Perception in Hungary and the United States," *Social Behaviour* 1:55-66.

Fischhoff, B., et al., 1979, "Which Risks Are Acceptable?" *Environment* 21(4):17-20, 32-38.

Karpowicz-Lazreg, C., and E. Mullet, 1993, "Societal Risk as Seen by the French Public," *Risk Analysis* 13(3):253-258.

Keown, C.F., 1989, "Risk Perceptions of Hong Kongese vs. Americans," *Risk Analysis* 9(3):401-405.

Kuppers, C., 1988, *Probleme der Wiederverwertung von Radioaktiv Kontaminiertem Stahlschrott aus Kerntechnischen Anlagen*, IG Metall, Germany.

Slovic, P., et al., 1985, "Characterizing Perceived Risk," in *Perilous Progress: Managing the Hazards of Technology*, R.W. Kates et al. (eds.), Westview Press, Boulder, Colo.

Slovic, P., 1987, "Perception of Risk," *Science* 236:280-285.

Starr, C., 1969, "Social Benefit versus Technological Risk," *Science* 165:1232-1238.

Teigen, K.H., et al., 1988, "Societal Risks as Seen by a Norwegian Public," *Journal of Behavioural Decision Making* 1:111-130.

United Nations, 1993, *Sources, Effects, and Risks of Ionizing Radiation*, United Nations Scientific Committee on the Effects of Atomic Radiation, New York, N.Y.