HOW DOES ONE COMMUNICATE "ISOLATION OF WASTES FROM PEOPLE AND ENVIRONMENTS?"*

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ABSTRACT

Federal and state laws, rules, and regulations governing/controlling management of radioactive, hazardous, and mixed radioactive-hazardous wastes are replete with discussions about **storage** and **disposal**. Whereas the meanings of these words are clear and simple, politicians, regulators, engineers, and scientists have so twisted the meanings that differences between them are slurred. This paper focuses on the misuse of these words and contends that what federal and state governments, scientific and engineering communities, and other parties want is **isolation** of wastes from people and environments. The paper illustrates how ancient peoples successfully isolated their trinkets from people and environments for millennia, using mostly stone-age tools. It argues that modern man should be capable of isolating his exotic trinkets from the same for multiple millennia, using modern metallurgical techniques, ceramic chemistry, and computer wizardry, augmented by a more precise vocabulary and revised educational strategy.

INTRODUCTION

Ancients isolated things from peoples and environments for millennia. In many instances, they built structures that endured repetitive anthropogenic and environmental holocausts. According to Desroches-Noblecourt (1), Smyth (2), and Hammond (3), those people simply designed structures that would endure forever, because each would contain valuables important to those doing the construction and influence generations of peoples for eons. Their edifices ranged from earthen mounds (4,5) constructed in moist environments, to complex stone structures in jungle environments (6); and from incredible stone monuments in low-land and high altitude desert environments (2,7,8), to elaborate excavations in stone cliffs, complete with trickery to foil desecrators (1). Amazingly, the ancients accomplished those means both with and without written languages and mathematics, and certainly without the sophisticated metallurgy, industrialization, ceramic chemistry, computer wizardry, and credit card economics common to societies of the last decades of the twentieth century.

There exists little evidence that the ancients were preoccupied during design and construction as to whether the important personages and/or articles placed in their structures were stored or were disposed. They simply designed their structures to endure for eternity, and, as such, the contents were *isolated from* peoples and environments forever (1). In some instances, the interred personages were provided with "detailed operating procedures" (i.e., hieroglyphics inscribed on walls inside some Egyptian tombs, and on walls both inside and outside of Mayan temples) for reassembling delicate papyrus vessels (9) or conducting complicated sacrificial ceremonies (6) sometime during eternity. The important thing is – those ancient artisans accomplished their tasks free from regulatory encumbrances and meaningless debates on whether the contents of their creations were "in interim storage," "temporarily disposed," or "in permanent storage." Unfortunately, that luxury eludes modern artisans, regulators, public officials, and other parties. Modern man seems to overlook the fact that *stored* connotes a temporary situation, whereas *disposed* implies permanence. This paper focuses on misuses of these two words and offers a simple solution for regaining lost momentum toward satisfactorily resolving their associated waste management issues (i.e., constructing and licensing structures that isolate radioactive, hazardous, or mixed radioactive-hazardous wastes).

HISTORICAL PERSPECTIVE

The Egyptians, Maya, Inca, Anasazi, and various Native American peoples collectively called the "Mound Builders" of eastern and middle North America are famous for structures built using stone-age or, at best, simple metal implements. The Egyptians built pyramids in and around Giza 2500 years before Christ, and they chiseled elegant tombs in stone cliffs in the Valley of Kings near Thebes as early as 2000 years before Christ (1,2,10,11). The Maya built cities around massive, pyramid-like temples throughout the jungles of Guatemala, Belize, and the Yucatan Peninsula of Mexico, from about 800 to 1500 *anno Domini* (3,6,12). The Inca built cities, pyramid-like temples, complicated irrigation systems, and highways from sculptured stone (with each

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stone cut so precisely that there is scarcely space between adjacent blocks) in xeric environments on the western slopes of the Andes of Peru and Bolivia, from about 200 years before Christ to 1600 *anno Domini* (7). The Anasazi also built large cities, with recessed ceremonial chambers, elaborate irrigation systems, and highways from stone, in intermontane deserts of the southwestern United States between 800 and 1250 *anno Domini* (8,13). And, the Mound Builders constructed hundreds of earthen structures for use as ceremonial facilities, burial sites, defensive fortifications, and supports for villages in swampy areas throughout mesic environments of eastern and middle North America [and, for that matter, contemporaries built similar structures in like environments in Europe and eastern Asia], between 1000 years before Christ to 1700 *anno Domini* (4,5,14). [According to Stuart (15), Monk's Mound near East St. Louis (Illinois) was several times larger (both in area and volume) than the Great Pyramid of Cheops.]

Archaeological excavation of remnants of those civilizations has yielded a plethora of fragile artifacts and trinkets, including mummified dignitaries; delicate vases, pots, and baskets; wooden carvings and figurines; delicately embroidered ceremonial clothing; intricately braided ropes; exquisite paintings (e.g., pictographs and hieroglyphics); jewelry; and various lounging, recreational, and transportational devices. Archaeologists have mused that, if it were not for the efficiently designed and constructed edifices, certainly the environmental conditions, desecrators, and frequent conflicts between hostile peoples would have destroyed those treasures long before being discovered through recent intellectual and scientific pursuits (1,6,9).

Indications in the literature note that, as recently as only a few decades ago, modern scientists and engineers were focused on isolating radioactive wastes from people and environments. For example, Meyers (16) summarized plans for long-range management of nuclear wastes in the United States, when he noted that "Mined repositories for geologic isolation of waste have been under study since the late 1950s..." Heineman, Carbiener, and Basham (17) continued that theme, noting "...the rooms and corridors of the repository would be filled...and...shafts and boreholes...plugged to complete the isolation of wastes from the biosphere..." [Editorial paraphrasing and emphasis added by authors of this paper.]

However, somewhere in the middle to late 1980s, the nuclear industry, U.S. Department of Energy, regulatory framework of the federal government, and private nuclear enterprises lost sight of the concept of isolating nuclear [and hazardous, and mixed radioactive and hazardous] wastes from people and environments. For example, Numark, Mattson, and Gaunt (18) summarized and compared management strategies for radioactive wastes in five countries. Briefly, they noted that, in the United States, high-level radioactive wastes would be disposed in deep geological formations, with a facility being built for **temporary backup storage** for spent nuclear fuel. In France, spent fuel would be held in **interim storage** before processing, because storage is a low risk technology. And in Japan, the Federal Republic of Germany, and Sweden, a similar **interim storage** philosophy would prevail before disposition. [Additional historical detail regarding waste management strategies and philosophies in those countries can be found in the treatise by Carter (19).] Weiner and Sugai (20) pointed to investigations at Hanford (Washington) being directed toward using basaltic rock for **storing** radioactive wastes from defense plutonium reactors. Additionally, they alluded to discussions in the Nuclear Waste Policy Act (21) regarding monitored retrievable storage of spent fuel as unnecessarily complicating waste management issues by redirecting attention from establishing a repository for disposal of high-level radioactive wastes to alleviating accumulation of spent fuel at commercial power reactors.

Standards for a high-level waste disposal site require isolation of waste from the environment, using active controls for the first 100 years and containment for the succeeding 10,000 years (22). The behavior of natural and manmade structures can be extrapolated from archaeological and geological studies. "The scientific and engineering professions are confident they can design a repository that can meet stringent environmental standards over the 10,000 years required by law."(22) Terminal disposal is a technically valid approach. But the risk associated with such disposal is not zero. Waste kept in containers near the surface of the earth is always subject to release by acts of nature, sabotage, or carelessness on the part of those supposedly watching over it (23). "No scientist or engineer can give an absolute guarantee that radioactive waste will not someday leak in dangerous quantities from even the best of repositories."(23)

STRATEGY

The strategy for correcting the present situation is simple – education. People must be educated about the realities and technical possibilities of managing all types of wastes. That means taking the message to educational systems and teaching young people in primary and secondary schools, students in colleges and universities, educators in advanced programs, and public officials at all levels of government. However, those delivering the message (most of whom probably would be scientists and engineers from the federal government, special *contractors to* the government, and industry at large) must understand and know how to use the principal tools of education, namely, the spoken and written word. The message they convey must be clear, simple, and positive, and delivered with minimum bias. The authors recognize two factors in communication that often compromise comprehensibility, namely, (a) the use of jar-

gon and (b) inadequate exchange of information between the government, industry, and public. These factors can lead to confusion and controversy with regard to waste management practices and issues.

JARGON

Every governmental, industrial, academic, societal, and theological organization or discipline has its own language, complete with terminology and phraseology, which serves to enhance communication within the organization or group and exclude eavesdropping by outsiders. That aspect of communication in the nuclear industry was explored by Reno and Walters (24). A similar aspect involves using technical and/or common words that have multiple meanings, so many so, in fact, as to be meaningless. If one looks up the definition of *dispose*, for example, one finds an entry such as the following from The American Heritage Dictionary:

dis • pose *v.* **-posed, -posing, -poses.** —*tr.* 1. To place or set in a particular order; arrange. 2. To put (business affairs, for example) into correct, definitive, or conclusive form. 3. To make willing or receptive for; to incline. —*intr.* To settle or decide a matter. —**dispose of.** 1. To attend to; arrange; settle. 2. To transfer or part with, as by giving or selling. 3. To get rid of; throw out or away. —*n. Obsolete.* 1. Disposal. 2. Disposition; demeanor.

In federal laws and regulations, however, the word *disposal* can have several meanings. For example, as used in the Low-Level Radioactive Waste Policy Act (25), disposal means the "...isolation of low-level radioactive waste pursuant to requirements established by the Nuclear Regulatory Commission under applicable laws." Amendments to that act in 1986 changed the definition to include "...requirements [established] by an agreement state if such isolation occurs in such agreement state..."(26)

The original text for the Nuclear Waste Policy Act of 1982 (21), as found in the Congressional Record (27), defined disposal as "...long-term isolation of high-level radioactive waste or spent fuel in a repository." The final text for the Act, however, defined disposal as "...emplacement in a repository of high-level radioactive waste, spent nuclear fuel, or other highly radioactive material with no foreseeable intent of recovery, whether or not such emplacement permits the recovery of such waste." Even though the purpose of the Act (as stated in Section 111) is to "...protect the public health and safety and the environment...," one must refer to the definitions of "engineered barrier" and "repository" for a discussion of whether and how the waste will be isolated from the environment.

The Resource Conservation and Recovery Act (28) defines disposal as the "...discharge, deposit, injection, dumping, spilling, leaking, or placing of any solid waste or hazardous waste into or on any land or water so that such solid waste or hazardous waste or any constituent thereof may enter the environment or be emitted into the air or discharged into any waters, including groundwaters." To further confuse the issue, the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (29) defines a *release as* "...spilling, pumping, leaking, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing into the environment." In order to define these two terms, a more complete list of synonyms could not be found, even in Roget's Thesaurus!

If the meanings of *dispose* and *disposal* are unclear to the technical and regulatory communities, what meanings does the layman assign to these words? Chances are the meanings are just as unclear. Cherry (30) points out that, "A word is more than an arbitrary written or spoken sign, it is all that it carries in association as well. Words play upon our feelings and tap our memories." Reno and Walters (24) showed how negative words can mislead the public and news media, and concluded that, if such words are not purged from technical languages of the nuclear industry, "It will be a formidable task to convince some environmentalists, legislators, and communities as to the worthiness of a commercial nuclear waste repository in their area."

POOR COMMUNICATION

Communication of precise meaning is not an easy task; but, it is possible, provided the communicator takes time to select words that convey single, simple, and accurate thoughts. That behooves the communicator to ask, "Who is the intended audience?," remembering first that the message is directed to the individual in the audience whose command of the English language is that of a second language. Such a realization forces the communicator [author or orator] to be selective in the usage/meaning of each word. After that, one can embellish the language with those technical and artistic words necessary to impress and mesmerize the audience for whom the message is intended. Dale and Hager (31) noted that there are seven interrelated aspects of effective communication: (a) define the audience; (b) define the purpose of the writing [or oration]; (c) make sure the logic of the material is clear; (d) break the material into digestible parts; (e) keep the vocabulary as familiar as possible; (f) summarize and repeat at appropriate points throughout the material; and (g) personalize the approach, where appropriate.

Whereas most professionals would subscribe to these aspects of communication, two aspects habitually are misused or overlooked in writing: aspects (c) and (e). "Make sure the logic...is clear" requires a simple and easy flow of related ideas. The number of ideas should be limited, and the writer must not provide more information than needed for understanding by the intended audience. Each idea must be developed fully – not telescoped or crowded. When

writing for public consumption, most scientists and engineers tend to document rather than communicate, or they try to squeeze too many ideas into too short a space by using familiar shorthand expressions (e.g., jargon or acronyms – the subject of another paper planned by the authors). If the audience is to fully understand the writer, concrete explanatory material must be used, not the familiar jargon typically used among peers.

"Keep the vocabulary as familiar as possible" is a special challenge to writers of technical material. Not only must writers select the general vocabulary for the intended audience, they must find the most effective way to present the technical material. Keep the technical terms limited to those essential to the theme. The good writer will define technical terms in context whenever possible (i.e., through parenthetical expression). A new technical term should be introduced carefully via detailed explanation, but only after thoroughly researching the term for possible homonymity. Thereafter, repetition is in order, using the word clearly, with positive and familiar language.

AN EDUCATIONAL PROGRAM

Behavior and attitude are linked – behavior affects attitude, and attitude simultaneously affects and effects behavior. Everyone has predispositions, including selective exposure, selective perception, and selective retention. The authors contend that part of the difficulty of communicating the concept of "isolation of wastes from people and environments" lies in the phenomenon known as SELECTIVE PERCEPTION. The words used and heard by a person have no meaning in and of themselves. Meanings are assigned to words through environmental conditioning. Weiner and Sugai (20) concluded that a change in public perceptions is needed with respect to the acceptability of a waste site and the credibility of the federal site investigations. Krauskopf (23) argued that the technical expertise to isolate high-level radioactive waste is available. However, there is not unanimity, even among experts, regarding the integrity of a waste site for 10,000 years. For that reason Krauskopf asked the questions "...should repository construction be authorized? Or should it be delayed pending results of further research? Those are not technical questions, but questions for the man in the street and his elected representatives."

The federal government, through the Department of Energy, Nuclear Regulatory Commission, and Environmental Protection Agency, should inform, educate, and, in many cases, re-educate the general public regarding isolation of wastes. Education must be from the bottom up, not the top down. The younger the individual is, the fewer his or her predispositions. By taking the message to the youth, fully formed opinions about nuclear and/or hazardous wastes, and long held attitudes and dogmas of society might be circumvented. Private industry also needs to deliver the same or similar messages. The best educational strategy is to communicate fully and openly. Answer questions as soon as they are asked, using simple, positive language. Dwell on the positive aspect of the idea and be honest about negative aspects. Above all, leave the arrogance common to government, industry, and enlightenment elsewhere.

In some ways, the Department of Energy already is actively delivering the new message. It is accomplishing that through educational subsidies to academic institutions, financial assistance for graduate education, training of select undergraduate and graduate students at national engineering laboratories, and special training of educators from elementary and secondary schools, colleges, and universities through the same laboratories. Those are beginnings, but, sadly, they reach too few people over too long a period of time. What is needed is an educational *Blitzkrieg*, followed by long-term, positive reinforcement, focused on the youth, and supported by governmental, industrial, and professional and scientific organizations. The youth are the individuals who will build and permit the structures that will isolate wastes; they are the ones who will write or rewrite laws, rules, and regulations controlling and directing waste management strategies and operations; and they, most probably, are the people who will be regarded as the benefactors of succeeding generations.

RAMBLINGS

Certainly ancient man was successful. He passed along to modern man countless gifts (e.g., domesticated plants and animals), breathtaking pieces of art (e.g., treasures from the tomb of Tutankhamen), important pieces of literature (e.g., the Old Testament and Rosetta Stone), and astounding examples of architecture (e.g., the Sphinx, Machu Picchu, and Pueblo Bonito). Yet, modern man is prepared to pass along to his successors a legacy of ineptitude in dealing with industrial and environmental externalities stemming from affluence, despite his technical and financial gadgetry, sorcery, and managerial planning! That is unfortunate, because modern man has all the tools and skills he needs to manage easily and quickly the nuclear and hazardous wastes, in ways that would isolate such from people and environments forever. Why he does not choose to do so is an enigma to the authors. Instead, modern man entangles himself in meaningless debates over such insignificant things as whether something is either stored or disposed. Such things are morsels for entertaining academicians.

It seems logical to the authors, that, if ancients could use stone-age or primitive tools and techniques to build structures for containing and protecting fragile and sacred items for millennia, modern man should have no difficulty isolating his exotic trinkets for countless multiples of millen-

nia. As hard as we tried, we could find no evidence of a pharaoh ever leaking from a pyramid. Surely, modern man [and his successors] should never find traces of plutonium or polychlorinated biphenyl leaking from his "pyramids," because he HAS the metallurgical, geological, sociological, chemical, environmental, and political skills to isolate whatever from whatever, whenever, forever. We suggest that the focus be shifted from debating whether something is either stored or disposed, to concentrating on perpetual isolation. Then, it will make no difference whether the structure affording that quality is deep in geologic formations, under the surface of the ground, on the surface, or, for aficionados of the famed television series STAR TREK, on "Stratos." Nor will it make any difference whether that which is isolated is being held in retrievable storage, moist or dry environments, populated or rural communities, or in the middle of "nowhere." In all cases, that "whatever" would be ISOLATED! As a result, each of us [and our successors] could get on with living and pursue more rewarding endeavors. That accomplishment, if accepted by modern man, could be the legacy he passes along to his successors – a legacy rivaling anything contributed by his ancestors to his present day well being. Perhaps the key lies in education, focusing the informational process on all levels of academics – especially grade schools. The youth of today will be the voters, politicians, engineers, scientists, and regulators who will build, permit, use, and benefit from such facilities tomorrow.

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