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Thomas G. Grumbles XF: None

To Environmental Coordinators Date 4/22

Attached is another article dealing with Risk Communication. The table on p. A-226 is a good summary of the issues

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Risk is Normal to Life Itself*

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Health and safety professionals face an enormous challenge. We must communicate about safety in the context of all risks that society faces. The health and safety professional must be scientifically accurate while working in an atmosphere that is frequently emotionally charged. As professionals, we face decisions that force us to balance voluntary risks and externally imposed risks. How do we set "safety levels" in this context? Even more important, are we allowing rational risk decisions to be relegated to computerized risk analyses that have so many compounded errors that common sense tells us the estimates are clearly wrong? Absurd conclusions, of course, lead to loss of credibility in the entire field of risk assessment. In an emotionally-charged environment, perceptions are reality. Perceptions are frequently far from scientific reality, but perceptions are so strongly held that scientific reality alone cannot change opinion. Until risk communicators learn to address perceptions concurrently with scientific reality, we will find little improvement in the general understanding of relative risk and, hence, little acceptance of slight risks. No one has the correct answer to effective risk communication yet, but we must continue the search for optimum communication techniques.

Background: Our Lives Are Surrounded by Risks

A fetus faces risk from the moment of conception. If the baby has the misfortune to "select" the wrong parents, it can inherit such genetic diseases as hemophilia, diabetes, sickle cell anemia, Down's syndrome, retinitis pigmentosa, Alzheimer's disease, spina bifida, hydrocephalus, or many others that are still being identified. The baby could inherit a predisposition for conditions such as heart disease, cancer, allergies, obesity, alcoholism and many others.

While in the womb, babies are exposed to involuntary risks based on their mother's lifestyle. If mother smokes five or more cigarettes a day, the baby might have a lower birth weight or even a risk of childhood leukemia or Whilm's syndrome. If mother drinks alcohol while pregnant, baby runs the risk of mental retardation. If mother takes certain drugs, birth defects—such as those induced by thalidomide—are possible. If mother has certain diseases such as AIDS, measles, or other viral infections that can be transmitted through the placenta, then serious risks of deformity are very real. Mothers who use "recreational drugs" can turn their newborns into infant "junkies," and many newborns do not survive drug withdrawal after birth. In fact, recreational drugs such as marijuana reduce sperm counts and motility. Therefore, potential fathers who smoke pot may not be able to fertilize an egg. This is the child's only possibility of having "zero risk."

I haven't even reached the point of birth where mother's blood type might be incompatible with the baby's, resulting in Rh problems and a high infant death rate if not treated immediately. Maternal venereal disease can lead to infant blindness or AIDS. The birthing process itself can lead to brain damage or other complications.

The infant years are fraught with dangers of accidents and childhood illnesses. With all of these risks, it seems hard to believe that so many of us grow up to be adults. Yet, we are generally living longer and healthier lives world-wide than ever before in history (with the exception of the Soviet Union where life expectancy is decreasing and in a few countries where the rate is essentially constant).

I give these examples to put things into perspective. We expect to see these risks reduced. In fact, through technology and human efforts, risks are being reduced. Whenever a case of botulism is identified, for instance, it makes national headlines. Botulism and related food infections were common causes of death before refrigeration and modern food processing techniques and were unworthy of news coverage just two generations ago.

We live longer now because we have a cleaner environment, medicines, vaccines, preservation of foods, freezers and refrigerators, vaccination, proper nutrition and because of other factors common to our higher standard of living. Today life expectancy in the United States is higher than at any other time in history, and each year life expectancy increases.

We live in a society that expects technology to provide a risk-free utopia. As we all know, utopias do not exist, and energies spent trying to reach an unrealistic goal are spent in vain. As practitioners in risk reduction, we should strive to reduce risk to a level that reaches toward zero, but any attempt to actually try to reach absolute zero will mean misspent resources.

Approaches to Risk Communication

Perception is reality. I know this is a difficult thought for a scientifically-trained person, but the more work I do in communications, the more I have come to believe the adage that perception is reality.

If we look at the messages that bombard us daily, we can see that many messages do not fit the facts. For example, a government employee union is running an advertisement on Washington TV that says that water cleanup isn't working

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TABLE I
Risk Ranking Based on HERP from Ames, *et al.*[1]
(Human Exposure Dose/Rodent Potency Dose)

Daily Human Exposure	Carcinogen Dose per 70-kg Person	HERP %
Tap water (1 L)	Chloroform, 83 μg	0.001
Contaminated well water (1 L) (worst well in Silicon Valley)	Trichloroethylene, 2800 μg	0.004
Well water (1 L, Woburn, Mass.)	Trichloroethylene, 267 μg	0.0004
	A. Chloroform, 12 μg	0.0002
	B. Tetrachloroethylene, 21 μg	0.0003
Swimming pool (1 hr) (average child)	Chloroform, 250 μg (average pool)	0.008
Conventional home air (14 hr/day)	A. Formaldehyde, 598 μg	0.6
	B. Benzene, 155 μg	0.004
Mobile home air (14 hr/day)	Formaldehyde, 2.2 mg	2.1
PCBs: daily dietary intake	PCBs, 0.2 μg (U.S. average)	0.0002
DDE/DDT: daily dietary intake	DDE, 2.2 μg (U.S. average)	0.0003
EDB: daily dietary intake (from grains and grain products)	Ethylene dibromide, 0.42 μg (U.S. average)	0.0004
Bacon, cooked (100 gm)	A. Dimethylnitrosamine 0.3 μg	0.003
	B. Diethylnitrosamine, 0.1 μg	0.006
Sake (250 mL)	Urethane, 43 μg	0.003
Comfrey herb tea (1 cup)	Symphytine 38 μg, 750 μg of pyrrolizidine alkaloids	0.03
Peanut butter (32 gm: one sandwich)	Aflatoxin 64 ng (U.S. average 2 ppb)	0.03
Dried squid, broiled in gas oven (54 gm)	Dimethylnitrosamine 7.9 μg	0.06
Brown mustard (5 gm)	Allyl isothiocyanate 4.6 mg	0.07
Basil (1 gm dried leaf)	Estragole, 3.8 mg	0.1
Mushroom (*Angaricus bisporus*), one raw (15 gm)	Mixture of hydrazines, *etc.*	0.1
Natural root beer (354 mL) (now banned)	Safrole, 6.6 mg	0.2
Beer before 1979 (12 oz)	Dimethylnitrosamine, 1 μg	0.008
Beer (12 oz)	Ethyl alcohol, 18 mg	2.8
Wine (250 mL)	Ethyl alcohol, 30 mg	4.7
Diet cola (12 oz)	Saccharin, 95 mg	0.06
Formaldehyde: Workers' daily average intake	Formaldehyde, 6.1 mg	5.8
EDB: Workers' daily intake (high exposure)	Ethylene dibromide, 150 mg	140.0

and the government must be forced to do more. The Clean Water Act was just reauthorized for $20 billion, and the water quality in the United States has improved to a point where many previously polluted waters now host swarms of swimmers without fear of polluted water. The advertisement clearly flies in the face of facts, but the image is retained, and people who see the ad will firmly believe that the government isn't doing anything to clean up water. Their perception becomes political reality.

Likewise, many risks are ingrained in our minds that do ot fit scientific reality—both positive and negative. People perceive risks they don't understand as far more serious than risks they do understand. Risks with positive benefits will be subconsciously ignored or played down while risks associated with no benefits will be magnified beyond their reality. This "risk understanding gap" is best exemplified in Table I where commonly accepted environmental hazards are compared with common materials in our daily lives. Another example is the public tolerance of smoking versus environmental standards. The risk of smoking is far greater than living near most hazardous waste management sites, yet smokers will continue to smoke as they worry about the risks from landfills.

Human nature will opt to blame external forces when faced with adversity of its own making or of unknown origin. This is especially true when we face risks with chronic and severe outcomes.

Risk perception is not rational. Risk perception does not follow the normal laws of science and can be based on fear of the unknown, fear of the outcome, fear of the financial impact, fear of loss of control of one's fate, or many other factors independent of reality.

As scientists, we must learn to put risk in perspective and help the general public understand that perspective. Since risk is such a scary concept, our first problem as risk communicators is to put risk in the context of daily life.

Perhaps we, the risk communicators, are to blame for some of the public's misunderstanding. We all talk of risk while we control for safety. Perhaps we should talk of safety factors rather than risk factors.

A major difficulty with identifying risks centers on diseases that have many causes. Confounding causes of diseases are very difficult to separate, making it very difficult to assign a single cause to a disease. For example, lung cancer can result from causes unknown, from use of cigarettes, and from asbestos, silica and other fine-particle respiratory dusts. Separating the causes of cancer—industrial exposures, pollution, and many lifestyle factors—is most difficult and requires sophisticated statistical and epidemiological methods. Many who try to link cause and effect without these advanced techniques can easily reach erroneous conclusions.

Any effective system of risk communication we develop must be based on the best science available, but I am becoming convinced that purely factual communication is ineffective. Factual information must be communicated in the context of comparisons and should show risks relative to other, similar situations.

Dr. Bruce Ames[1] demonstrated an excellent way to put carcinogenic risks in perspective. He developed a system called HERP, human exposure dose/rodent potency dose. While the rodent is far from the ideal model of human toxicity because its metabolism is often dissimilar, it has the advantage that more data exist for the rat than for other animal models. Table I contains excerpts from his paper published in *Science*.[1]

Yet, in its original form, HERP is not as effective a risk communication tool as it might be. I took the liberty of expanding Dr. Ames's table to include comparisons of various daily human exposures with a glass of wine and beer (Table II). I feel that we must communicate risk on the basis of something that people accept as safe and something in their daily environment.

We all accept risk as a fact of life, either consciously or unconsciously. Other factors intrude into our acceptance of risk. These factors include

- severity of the outcome,
- proximity of the outcome,
- ability to control exposure to the risk,
- pain and suffering resulting from the adverse consequence,
- peer pressure to accept the risk,
- ability to blame someone else for the adverse outcome,
- perceived benefits, and
- degree of uncertainty in the risk (the more uncertain, the greater the fear).

Involuntary versus voluntary risk arguments may be a trap. All too often we are sidetracked into exploring these issues, but I think voluntary/involuntary risk is a blind trail. Involuntary risk exposure is not the issue; rather it is an inability to control decisions affecting our personal environment. The public is losing faith in the government's ability to protect us—even if data show that we are living longer and healthier lives than ever before. Risk isn't the issue; loss of freedom is part of the issue.

TABLE II
Hazard Comparison with Beer and Wine
(Based on Data from Ames, *et al.*[1])

	Times Less Hazardous than 1 Glass of	
Daily Human Exposure	**Beer**	**Wine**
Tap water (1 L)	28 000	4700
Contaminated well water (1 L) (worst well in Silicon Valley)	700	1200
Well water (1 L, Woburn, Mass.)	7000 A. 14 000 B. 9300	12 000 A. 24 000 B. 16 000
Swimming pool (1 hr) (average child)	350	590
Conventional home air (14 hr/day)	A. 4.7 B. 700	7.8 12 000
Mobile home air (14 hr/day)	1.3	2.2
PCBs: daily dietary intake	14 000	24 000
DDE/DDT: daily dietary intake	9300	1600
EDB: daily dietary intake (from grains and grain products)	7000	1200
Bacon, cooked (100 gm)	A. 930 B. 467	A. 1600 B. 780
Sake (250 mL)	930	1600
Comfrey herb tea (1 cup)	93	160
Peanut butter (32 gm: one sandwich)	93	160
Dried squid, broiled in gas oven (54 gm)	47	78
Brown mustard (5 gm)	40	67
Basil (1 gm dried leaf)	28	47
Mushroom (*Angaricus bisporus*), one raw (15 gm)	28	47
Natural root beer (354 mL) (now banned)	56	24
Beer before 1979 (12 oz)	350	590
Beer (12 oz)	1	1.7
Wine (250 mL)	0.59	1
Diet cola (12 oz)	47	78
Formaldehyde: Workers' daily average intake	0.48	0.81
EDB: Workers' daily intake (high exposure)	0.002	0.03

(Please refer to Table I for additional detail.)

Risk communicators make a very serious error about their audiences for the communication message. The communicators assume that the audience will absorb facts when the reality is that risk communication is received emotionally, not factually.

Peter Sandman[2] says that the issue is moral and ethical, not factual. The more I work with risk communication, the more I tend to agree with his observation. We must learn to communicate factual information about safety factors while we communicate within an emotional context.

Sometimes we are our own worst enemy. We use an emotionally-laden vocabulary when we communicate risks. We don't think about our choice of words. We talk of risk, not safety; toxic waste rather than industrial waste; air toxics, not air quality; need-to-know, not right-to-know; *etc.* Technical folk commit a serious sin of jargon and of convoluted communication. We must learn the old public relations adage, KISS—Keep it simple stupid! For those of us who worked hard to develop a good vocabulary, it seems sinful not to use it. We must remember our objective is to communicate understanding, which is best done in simple terms.

In the early debates about environmental quality, cost/benefit analyses were common arguments. Industry predicted dire consequences if it had to meet the burden of strict environmental controls. Industry predicted many plant closings and lost jobs. When these closings did not happen immediately after tighter environmental controls, these arguments began to ring hollow. In the present economic climate, however, manufacturing industries are losing jobs. For example, the chemical industry employs 100 000 fewer people than it did 7 years ago. Much of that loss may be due to international competitiveness, but some is due to increased regulatory burdens that made industry less competitive in the international market.

The real question is, "Are the environmental and health controls necessary in this form?" If the answer is technically "yes," then the regulation should be there, and industry should comply or go out of that line of business. If the answer is "yes" based on sociopolitical, emotional judgments, then the regulation should not be put into effect. Unfortunately, far too many regulations fit the latter rather than the former. If we are merely wasting our resources rather than solving a real problem, then we will eventually run our costs so high that we can no longer compete internationally.

We live in a different time now. We live in a period where safety controls are set at such low levels that cost truly becomes a major factor. Perhaps we need to revive the old cost/benefit concept in these cases. If we are trying to control a one-in-one-million risk, especially for chronic disease, the model is probably conservative to a point of absurdity. For example, one Environmental Protection Agency (EPA) model estimating risk of children eating contaminated soil was 100 million times overly conservative.[3] The cost, in this case, was buying the entire town of Times Beach. At times like this, I feel that risk decisions have reached a point of

TABLE III
Observations on Risk and Risk Communication

On Risk

- Life cannot exist without risk.
- Without assuming some risk, societies cannot grow or prosper.
- Change is healthy in ecosystems and societies. With changes come some risks. Without changes comes death.
- The absence of something, such as harm, cannot be proved; only the presence of something, such as harm, can be proved.
- Risk from injury or illness is lower now than it has ever been in society.
- Without some risk, one cannot receive benefits.

On Emotion

- Fear is the strongest human emotion. Risk plays to fear.
- The greater the uncertainty about the risk, the greater the emotional turmoil about the issue.
- Risk implies uncertainty. People are more comfortable with certainty in their lives.
- The lower the understanding of the science relating to a specific risk, the lower the willingness to accept risk (assuming benefit and real risk remain constant).
- Risk should not be considered in isolation. Rather, risk should only be considered within the context of the full spectrum in which the risk is assumed. What is the risk of taking no action? What is the risk of the alternatives and the benefit of the alternative actions? These should be presented as a full analysis rather than a single number.

On Society

- The public feels that injury caused by involuntary risk should be compensated (either by those directly responsible for the injury or by the greater society).
- Reasonable risk is a societal judgment that the benefits to the many outweigh the small risks to an unidentifiable individual.
- General societal benefits do not justify an individual assuming a disproportionate burden of risk without an individual benefit.
- In general, older people are less willing to accept risk than younger people. The United States has a rapidly aging population, so we can expect it to be increasingly less willing to accept risk.
- As the industrial component of our economy shrinks, the public's willingness to accept risk decreases.

On Individuals

- The degree of freedom an individual has is directly related to the responsibility the individual assumes for his own actions.
- A person's ability to handle uncertain risk and responsibility cannot expand if it is taken away from him.
- People accept less risk when they attain a zone of comfort, certainty, control or trust than when they are struggling for survival.
- An individual will assume what society would consider an unacceptable risk if he perceives a personal benefit.

On Perception

- Public perception is reality and must be addressed in whatever solution is proposed.
- Most people view risk as negative.
- Political action responds to perceived crisis. Good technical solutions come from dispassionate logic. In highly emotional situations the two may not converge.
- Both political and technical solutions are necessary to solve problems.

On Communication

- Risk communication is negative. To communicate acceptable risk, we must change the vocabulary to a positive, *e.g.*, degree of safety.
- Numerical calculations should not be used to communicate risk. "Parts per . . ." communications should be abandoned because the public only hears the large number at the end of the phrase and thinks the value is very large rather than infinitesimally small.
- The media cannot be counted on (or expected) to do any more than report or deliver the risk message it receives. Thus the messenger must be a skilled communicator who is knowledgeable in the field.
- The effectiveness of a risk communication should be judged by the effect (response) it creates.
- Doing the right thing isn't news.
- Activists will create stories that emphasize risk rather than safety. It's almost impossible for industry to generate stories in the media that emphasize safety.
- The earlier the stakeholders in an issue talk to each other and try to reach a common definition of the problem, the faster a solution can be reached. It will be a better solution, too.

absurdity. No wonder the public places little credibility in scientists.

While considering risks, risk perception and reality, I have collected a series of observations on risk. These thoughts are contained in Table III. I offer them as food for thought to anyone who has to struggle with risk communication.

We all face an overwhelming problem in the immediate future. The Superfund Amendments and Reauthorization Act of 1986 (SARA) requires communications with communities and emergency response personnel. SARA requires material safety data sheets (MSDS) at fire stations if they are requested by fire departmental personnel. The real goal of the law should be access to hazard information that is current and easily accessible. We all agree with the goal, but implementation of the letter of the law is a blueprint for disaster. The overwhelming requirements for material safety data sheets will not satisfy the real need of providing information and understanding. They might represent health hazards from hernias and back strain as fire fighters move large boxes of material safety data sheets, or they could represent fire hazards with all of the paper that must be stored at the fire station.

Professional societies should unite with industry, unions, local emergency responders and special interest groups to design a system that works. The chemical industry established the Chemical Referral Center (CRC), a toll-free number for anyone to get product safety information (for nonemergency information). We currently have more than 130 000 MSDSs on chemicals in our system. The information number is 1-800-CMA-8200. The CRC was in operation before the current law was passed, as a response to the need for chemical information by the general public. While this may not be the ultimate answer to meeting the public's need to know, we feel that it is a practical option to provide information quickly and with more personal attention than could be possible with an MSDS.

Conclusion

Risk communicators must be sensitive to the needs of their audiences. Yet all of our training teaches us to be unemotional and scientifically objective. The mixture of approaches we traditionally use makes us appear uncaring and unapproachable. To communicate safety with proper perspective, we must become humanists who continue to seek bias-free risk assessment.

An unwritten contract exists between management and labor in the chemical industry. Management has an obligation to provide a safe workplace, necessary safety equipment for the situation, and training for anyone who will be working in a potentially hazardous environment. Labor has an obligation to use the protective equipment provided, learn and use safe procedures, and work in such a manner that minimizes risks. Both parties of the contract—management and labor—need to work diligently on their respective sides of the unwritten contract to achieve safety. This works well in the chemical industry and has resulted in a safety record that other industries envy. We know that no amount of regulation will bring safe work conditions until this social contract between labor and management is manifest.

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