Nuclear safety – culture or obsession?

Heldio Pereira Villar

Centro Regional de Ciências Nucleares
Rua Cônego Barata, 999 – Tamarineira
Recife, Brazil 52110-120

Escola Politécnica de Pernambuco
Praça do Internacional, 455 – Madalena
Recife, Brazil 50750-470

Abstract. Although nuclear activities are among the safest, having an enviable record in this respect, public perception is quite different. It is argued here that, regardless of the fact that environmental groups and the media in general look unfavourably towards the nuclear sector, the emphasis the sector places on safety matters is a liability rather than a asset. In short, public acceptance of a risky enterprise increases with the safety concerns shown by an entrepreneur up to a certain point. Beyond this threshold the enterprise is found too risky to be accepted, and it looks like the nuclear establishment has already crossed it. Ideas for further relationship with the public are then shown.

1. Introduction

It can be argued that the word "nuclear" is more frequently associated with "safety" than with "energy". Although the common man does not usually refer to nuclear safety, every time he reads about or talks about nuclear energy, concerns about safety are implicit. This should be good news, were it not for the fact that the common man perceives all nuclear activities as inherently unsafe. This skewed perception was long attributed to the association between nuclear activities and the Hiroshima bombing. The idea that the world population could be wiped out in a flash was almost too much to bear, and any activity dealing with uranium or plutonium or radiation was likely to be seen as unacceptable. However, the fact that scores of wars have killed millions since 1945 and not one single atom bomb was dropped has certainly shown the public that a nuclear weapon is more nuclear than weapon. And hundreds of nuclear reactors have been operating for more than half a century, and not one of them came close to exploding like an atom bomb.

Despite the nuclear sector's enviable safety record (even the Chornobyl accident cannot be counted among the worst man-made disasters), news reports on nuclear matters are systematically negative and almost always full of mistaken data. They usually deal with "radioactive leaks", "radioactive doses", "exposure", "radiation contamination" (whatever that may be) and the like, and are not complete without words like "risk", "danger", "cancer" and "death". Inevitably, even minor nuclear or radiological accidents never fail to attract massive media coverage – and are never forgotten. An explanation for that is attempted here.

2. How much safety is too much safety?

A sizeable portion of man's activities throughout the centuries have centred on personal safety, starting with housing. Although it is not ethical to confer a monetary value to human life, the fact is that the rising cost of occupational accidents – in terms of loss of production, legal imbroglios and class action – was one of the main stimuli of the recent emphasis on personal safety. One way or the other, the culture of safety is, broadly speaking, something so deeply ingrained in everyone's mind that whenever a new product or technique is launched preoccupations with safety aspects very rarely are among the first priorities of potential users. It is implicitly assumed that whoever is capable of developing a product or technique should not be as incompetent or irresponsible to create anything unsafe.

In the old days, when this idea was not completely consolidated, acceptance of new ideas was far from immediate. One good example of the stepwise acceptance of a hazardous product is provided by the aeroplane. At first a very risky occupation, being almost solely the pastime of daredevils and stuntmen, flying nowadays provides a convenient, enjoyable and safe travel experience. Although it does not share with other means of transportation the possibility of mid-course stopping, flying is found safer by any yardstick. Even first-time flyers now enter jet planes with full confidence that nothing wrong will happen.

One interesting aspect of this public confidence in air travel is that it was not fuelled by any particular effort by airlines or aeroplane makers to stress safety. True, cabin crews are required by international law to demonstrate safety procedures just before takeoff, but very few passengers really bother to pay attention. But fear of flying is real, as the post-Sept. 11 syndrome showed. A zealous entrepreneur could well address this problem by stressing safety. His aeroplanes would be spotlessly clean and passengers would be shown maintenance reports indicating that parts are routinely replaced much earlier than technically required. While waiting for takeoff, passengers would watch a video explaining how recent air crashes occurred, being reassured that they would never happen to this company's planes. Finally, in order to allay any remaining fears, each passenger would be supplied, just in case, with a parachute.

It is not difficult to forecast the future of such a company (and even of all aviation industry, if such a company is ever launched): confronted with such an emphasis on safety, potential clients would certainly be completely terrified, because they had never been aware of the real danger behind air travel. The zealous entrepreneur crossed the threshold separating "enough safety" from "too much safety". Man has always lived with risks, and did his best to minimise them, especially when new technologies were introduced. The riskier the undertaking, the stronger the concern with safety, in order to deal with legal requirements, but mainly to ensure public acceptance. But there seems to be a limit to that, and a probable representation of the public acceptance of something risky is given in Figure 1. Given the direct relationship between risk and preoccupation with safety, if this preoccupation crosses a certain threshold the risk is judged too high to be acceptable. It looks like the nuclear sector has already crossed this threshold.

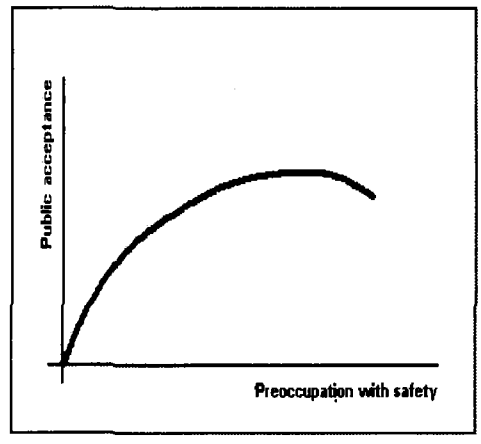

FIG. 1. How public acceptance of something inherently risky changes with safety concerns.

3. The case of nuclear safety

The concept that guides nuclear activities apparently states that they should be made entirely risk-free. This inevitably led to two alternatives: either these activities should be phased out or, in case some of them still had to be performed, no amount of effort and cash should be spared in order to guarantee that their risk was set as close to zero as reasonably achievable. Therefore, after having assured the world that all radiation doses, however small, could be harmful (through a strange concept known as linear non-threshold dose response, or LNT), after having created countless national and international associations devoted solely to the cause of radiation protection, after having swayed health authorities into passing legislation to control clinical X-ray exposure, after having convinced everybody that a tiny deviation of the planned dose in radiotherapy would kill the patient by rendering the applied dose either ineffective or deadly, these specialists told common man that they were so concerned with safety that neither him nor his progeny would ever be affected by nuclear activities, despite all risks associated with them.

Indeed, no economic sector is seen to be so obsessed with safety as the nuclear sector. This obsession is evident in the smallest details. Books on nuclear engineering, besides the usual engineering topics, will always add at least one chapter on the biological effects of radiations. Even the so-called popular

science books incorporated these trends: no book on radioactivity, nuclear energy, nuclear reactors or similar topics leaves aside Three Mile Island or Chornobyl. Which other engineering field would be so concerned with the effects of their activities on human lives? Which other human endeavour must stress that it is only promoting the peaceful use of anything? Which other economic activity (with exception of those having safety as their product) spends so much human and financial resources on one topic only, safety? Finally, which other sector, despite so many pledges, is still not trusted by the common man? Adepts of conspiracy theories credit this skewed perception of radiation, radioactivity and nuclear matters to oil and hydroelectric companies that would have plenty to lose by the proliferation of nuclear power plants. Others recall that radiation is an invisible threat, that can fatally affect people without their being aware of. What is the nuclear establishment's reaction to all that? It simply places more emphasis on safety.

Nuclear reactors, for instance, are surrounded by all types of biological barriers, in case anything wrong, however unlikely, happens. The reactor building is capable of withstanding the impact of a fighter jet loaded with conventional bombs. Redundancy systems are activated in case the standard systems fail. Environmental assessment in the area is carried out annually from the moment the reactor is planned. Moreover, no nuclear reactor is built before an emergency plan, necessarily involving the quick evacuation from a wide area, is designed and discussed with the community, the local government, the police authorities, the armed forces and so on. Of course, all these precautions are entirely justified. But other installations, like oil refineries or chemical plants, are also dangerous. However, the same precautions are not taken by their proponents, thus leaving the nuclear companies in the same position as the "zealous aviation entrepreneur".

Probably an even greater threat than the nuclear reactor itself is presented by the wastes it generates, although they are produced in very small amounts. All existing proposals to deal with radioactive waste are quite similar and start by choosing a suitable geologic formation (after countless studies and public hearings) as a final repository. In one of them, the waste is diluted and embedded in glass blocks. Each block is then encased in a steel drum full of concrete. Once this drum survives gruelling tests (broiling at 1000°C for one day, ramming by a 150 km/s locomotive), it is pronounced safe for burial.

Well, man has lived with toxic waste from immemorial times. Toxic chemicals are produced and disposed of in increasing amounts. Some are so dangerous that even minute quantities are capable of killing thousands. However, stricter regulations and a plethora of safety measures managed to reduce their risk to a minimum. But none of these regulations and measures compare with the almost sacred awe towards nuclear waste. It can be argued that the world will not become less safe if nuclear waste is treated like all hazardous waste, but it will be rendered unfeasible if all hazardous waste is treated like nuclear waste.

This is an area in which the common man's viewpoint should be heeded. He knows that highly-poisonous wastes are carefully sealed in steel drums that are later buried in engineered repositories, and he is satisfied with that. When confronted with the way nuclear waste is treated, can he be condemned if he thinks that, judging from the extreme precautionary measures taken, nuclear waste is so utterly dangerous that not only kills but also leads to eternal damnation, so that all nuclear activities should be immediately stopped? The irony is that all these precautions stem from the nuclear sector's safety culture. The philosophy behind radioactive waste management is that it should be disposed of in such a way as never to present any threat to future generations. This is clearly ideal, but negates future generations' ability to deal with environmental problems, besides being a highly questionable goal. Once again the "zealous entrepreneur" comes to mind.

4. Suggestions

It is commonly said that Caesar's wife must not only be virtuous, but above all look virtuous. However, if Caesar's wife roamed the streets of Rome proclaiming her virtue to the sound of drums and trumpets, the citizens would have all the right to be suspicious. So this is the nuclear establishment's present conundrum: it must assure the world that its activities are not unbearably risky without emphasizing safety, even though the potential risks have been raised by the nuclear sector itself. How is it to proceed?

In the first place, safety details can be presented in such a way as not to call attention to safety. Everybody knows what an electric switch is for, but it is in essence a safety device: connecting and disconnecting two wires would do the same job, but with a switch the risk of an electric shock is all but eliminated. By the same token, a nuclear reactor's containment building must withstand the collision of an aeroplane not only for safety reasons, but also to safeguard a one-billion-dollar machine. And X-rays exposures must be controlled not only due to radiological risk, but also to reduce costs and obtain better images.

Secondly, information, albeit accurate, must be conveyed in the simplest terms. If possible, a condition should be stated as either safe or unsafe, acceptable or unacceptable, and so on. Brazilians remember quite well when the government imported milk in 1987 and that this milk was branded as radioactive (some called it "Chornobyl milk"). Instead of commissioning one single laboratory to analyse the milk and issue a simple verdict on it (safe or unsafe), officials allowed the release of several different figures for the presence of radioactive materials in milk samples. Confronted with strange names like becquerel per gram, microsievert, permissible doses and, above all, with the conflicting results the laboratories periodically released, the population simply stopped consuming milk, thus risking malnutrition.

Thirdly, unnecessary connections between radiation or radioactivity and risks should be avoided. For example, well-meaning researchers have shown that tobacco contains natural radioisotopes (which is not surprising), but ended up by spreading the idea that smoking is harmful not because of nicotine or tar, but due to the inhalation of radioactive materials. And why stress all the time that a nuclear reactor will never explode like an atom bomb?

Finally, truth must prevail. Nuclear risks must be analysed, presented and dealt with accordingly, i.e., all safety procedures and their costs should be well justified. What is the point of telling a community that hundreds of millions of dollars are being spent to prevent an accident which is highly unlikely to happen anyway? And what will be the position of the nuclear establishment if something wrong does happen? Unfulfilled promises are by far the worst publicity.

5. Conclusion

The nuclear establishment disseminates the idea that it is a victim of the media, environmental groups and others that have put the public against it. Perhaps it is true. But it can easily be argued that after calling the attention for so many years to the safety aspects of nuclear activities and waging a campaign for the control of radiation doses that bordered the paranoia, the nuclear establishment has nothing to complain about: the 400-plus nuclear reactors that produce about one-fifth of the world's electricity, the nuclear fuel reprocessing plants still operating and the current use of radioactive isotopes are clear indications that if the public is not exactly enthusiastic about nuclear activities, at the very least it tolerates them. There is a universal tendency to take with a pinch of salt all concerns with

safety, especially if they look exaggerated. It is quite probable that the common man thinks that nuclear and radiation specialists have gone too far in their quest for safety.

In all, the nuclear sector, since it deals with palpable risks, must have a well-developed safety culture, which is certainly the main reason behind its fantastic safety record. However, this concern with safety seems to have crossed, at least on some occasions, the threshold that separates care from obsession. At a time when the world is beginning to feel that their energy needs will not be met by fossil fuels or hydroelectricity without significant environmental damage, nuclear energy appears as the obvious choice to bridge the gap to a time when more convenient energy forms are available. Food irradiation with gamma rays may be the answer to the pressing needs of agribusiness. Newer medical techniques using radioisotopes will extend the lives of millions, helping in the diagnosis and cure of many of today's fatal ailments. All this can only be possible if the common man perceives nuclear activities as risky but manageable (which they truly are). This perception, for its turn, can only be possible if the nuclear establishment exploits the advantages of its safety culture without looking obsessive towards it.