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Nuclear safety and human fallibility

By Richard Vaughan

I must reply to Geoffrey Sampson's article criticising the civil nuclear power industry, since it contains a number of common but fundamental misconceptions about its safety. There are five basic areas in which he is seriously mistaken: the idea that the industry is incapable of absorbing human ignorance and fallibility; the myth that the consequences of a serious reactor accident would be far worse than, say, the worst railway accident; the idea that the industry requires those involved to be "saints'; the implication that the British are complacent in their comparison of British and American safety standards; and lastly the suggestion that in time of war, reactors make particularly vulnerable and desirable targets. I will deal with each of these allegations in turn, but must add one pivotal point; namely that Mr Sarnpson has completely ignored any reasoned comparison in the inherent safety of alternative energy sources.

DEFENCE IN DEPTH

Principally, he takes the industry to task for being naive about humanity's intellectual limitations; just the opposite is true, for nuclear power stations are operated on the very assumption that accidents will occur. While no system can ever eradicate the possibility of human error, the consequences of such errors can be limited by a comprehensive "defence in depth" system, which is common to all nuclear power stations. Since the American Pressurised Water Reactor (PWR) has come in for a great deal of stick regarding its safety, I will cite this as an example.

A nuclear explosion in such a reactor is not possible, for the simple reason that the uranium used is not sufficiently highly enriched for an explosive reaction to take place. Uranium enriched to only three and a half per cent is no more capable of undergoing a nuclear explosion than wood or concrete. The only threat peculiar to a nuclear plant is a release of large quantities of radioactivity, caused by a loss of coolant. In a PWR, this is threatened if the water which absorbs the heat from the fuel rods should leak out of the system. The pipes which carry water to and from the pressure vessel are continuously monitored for leaks and designed to withstand earthquakes. The safety measures assume not just leaks from small cracks, but a "guillotine cut", in which the pipe is cut clean through and the two ends severed from each other so as to allow the water to gush out without impediment. To eliminate this threat, every reactor has an Emergency Core Cooling System, entirely independent from the main coolant circuit. This is required to go into operation instantly and automatically on the occurrence of a coolant leak, but can also be operated manually if the automatic system should fail. What would happen in the extremely unlikely event of the primary circuit and the ECCS failing completely? If this situation were to prevail long enough (several hours), the fuel would begin to melt through the pressure vessel and the concrete containment into the ground, where its heat would be dissipated. The danger would come from the gaseous and volatile fission products released from the pressure vessel. Even these, however, would not cause any damage, for the entire system is surrounded by a reinforced concrete building. Although the likelihood of this somehow breaking at the same time that the cooling circuits have simultaneously failed is almost incredibly remote, it cannot be declared impossible. Even then, freak weather conditions (namely a temperature inversion and a wind blowing towards a large population centre) would be necessary for a public catastrophe to occur. One of the inherent features of this scenario is the time it takes to evolve - quite long enough for any appropriate evacuation measures to be taken. It is thus little wonder that those who design nuclear stations believe the possibility of an accident killing a large number of people to be extremely remote over any given time period. The concept of "defence in depth' on this scale does not apply to dams, gas tanks, oil tankers and many other industrial intallations where only a single line of defence need be punctured to result in disaster. Equally

important, these accidents happen relatively suddenly, so there is no comparable time to implement appropriate safeguards.

NO FATALITIES

The ability of nuclear plants to absorb mechanical failure and human error has been proved with a vengeance. There have been around forty major civil reactor accidents in the western world, but the first fatality in the operation of one of these plants has yet to take place. For example, the well-publicised accidents at Browns Ferry and Three Mile Island both involved a morass of human errors which lasted for several hours, but in neither case was an immediate threat to human life even approached. Such basic errors as occurred in these accidents could not take place in other industries without large scale loss of life automatically ensuing. In fairness, I should point out that BNFL has awarded compensation to the widows of about half a dozen Windscale workers on a benefit-of-the-doubt basis, but this is a nuclear fuel reprocessing plant, where the defence in depth philosophy is harder to apply. (It should also be pointed out that since the nationalisation of the coal industry, the widows of 19,000 deceased miners have been similarly compensated.) With regard to the consequences of the world's best known reactor accident, Mr Sampson quotes Daniel Ford as saying that TMI was of the "Class Nine" order. This is wrong. Class Nine accidents involve major disruption of the core, followed by a catastrophic realease of radioactivity. By implication this includes failure of the containment building. In fact, no member of the public received a radiation dose greatly exceeding 100 millirems (equivalent to about two chest X-rays). This radioactivity escaped through an auxiliary building, and was a smaller release than that of the Mount St Helen's volcano in 1980. The containment functioned exactly as it was meant to, and prevented a major release from occurring.

Mr Sampson is corrrect to say that every accident leads to improved safety measures in the future, but his assumption that at each stage nuclear safety engineers think they have "now got things right" is quite wrong, and in this respect they have been misrepresented by journalists, who are forever saying, "its designers said this could never happen" and similar nonsense. The point which proponents of nuclear power have been trying to get across is that although serious accidents are not impossible, they are a good deal less likely to occur than many non-nuclear accidents, and if they do occur, their consequences are less severe than other types of accident.

UNREALISTIC CONJECTURES

I had better justify that last remark. For various reasons, the scenario of a maximum credible accident (MCA) in the nuclear industry has been deeply instilled into public consciousness. This involves consequences running into thousands of somatic and even genetic effects. This is exceedingly pessimistic, and deliberately so. To give some indication of how misleading it can be, let us see what the concept of MCA means when we apply it to something more familiar, such as the aviation industry. We know from experience that a serious plane crash can kill hundreds of people, and many such crashes have now occurred. But what is the worst possible air crash? It is not inconceivable that two jumbo jets could collide in mid-air, and subsequently fall into a packed sports stadium. Tens of thousands could die in such an accident, but it is by no means the "worst possible". If an air liner crashed into the liquid natural gas tanks at Canvey Island on its approach to Heathrow Airport, even larger numbers of people could subsequently be incinerated; if it crashed into an oil-fired power station or chlorine storage tank, there could be thousands of early deaths, compounded by delayed lung and bronchial diseases, cancers and possible genetic mutations.

These accidents are exceedingly unlikely to take place over a given period of time, but they cannot be called "impossible". Because the media love to dwell on the possibility of major catastrophes, and because lay people are unfamiliar with how nuclear reactors work, it has become widely believed that if ever a full-blown meltdown were to occur, thousands would automatically suffer. I cannot say that such an accident will never happen, but let me enumerate several reasons why this scenario is unrealistic:

1. Owing to the inherent properties of the materials involved, hours and even days may elapse between the initial loss of coolant and a state of emergency. Thus there is plenty of tirne for precautionary measures to be taken including the rectification of the fault or even evacuation of the immediate vicinity. The victims of an air crash have no such luxury. Nor did the victims of the Johnstown, Belluno and Machu dam disasters; (these killed well over 2,000 people each, with tens of thousands left homeless).
2. For reasons which have more to do with thermodynamics than safety, reactors are generally located far from dense population centres, so released fission products would incur fewer casualties than, say, the fumes of a burning oil refinery or chlorine storage complex, many of which are located in suburban areas.
3. Models indicating the release of fission products tend to assume that those which are chemically reactive, and hence most dangerous, are released as easily as the less harmful inert gases. This is manifestly not the case, for extremely high iodine retention has been observed and understood on a number of occasions before now. The world's most comprehensive reactor safety study, the Rasmussen Report, quite deliberately makes pessimistic assumptions as to the ease with which iodine and caesium are released, because it is considered sound practice to err on the side of caution in safety analysis. It is not true that the release of iodine at TMI was "less than expected by a factor of half a million". What this factor does indicate is the unrealistic assumptions which have formed the basis for regulating the American nuclear industry. The reference to a "surprise" in my last article was to laymen and journalists rather than nuclear safety engineers.

A MISLEADING COMPARISON

It should now be apparent that Mr Sampson's comparison between railway accidents and nuclear accidents is grossly misleading. His suggestion that the worst of railway accidents "will kill or injure no more than a few hundred people, almost all of whom will have voluntarily chosen to take the risk..." is wrong. I should remind him of a train crash outside Ottawa in November 1979, which necessitated the evacuation of 250,000 Canadians (three times the number who quite needlessly left the area around TMI some months earlier): virtually none of these people volunteered the risk of the accident, for the train was carrying a cargo of chlorine, which was widely dispersed when the train derailed. Several similar rail accidents have since taken place the world over, some of which have resulted in fatalities.

Another reason that Mr Sampson mistrusts the nuclear industry is that he believes it too easy for those involved to bend the rules in their own financial or political interests at the expense of safety. Apart from the fact that those who design and operate nuclear stations are generally closest to the radioactive materials and emergency switches, we should note that even accidents which involve no fatalities are not worth risking unduly, since the financial cost is enormous whenever damage to a reactor takes place. Even if one worked on the assumption that all pro-nuclear factions cared more about profits than their own health and lives (let alone anybody else's), one would still have to admit that it is bad business to run an unsafe shop, as Met Ed of Harrisburg will readily confirm.

Mr Sampson has also misunderstood the British assessment of the implications which TMI has for Magnox reactors and AGRS. It was simply pointed out to the media at large that the type of accident which happened at TMI was exclusive to reactor systems which involve two-phase coolants (i.e. water and steam). British reactors employ CO gas as a coolant, so the problem of a "hydrogen bubble" preventing coolant access to the upper third of the TMI 2 could not take place in Britain. It is also worth noting that the power density of British reactors is much lower than in PWRs, thus any hypothetical transient would take even longer to evolve, allowing operators many hours to render the reactor safe. (Again, compare this situation with air and dam disasters.)

BOMBS ON REACTORS

Lastly, Mr Sampson quotes a recent Scientific American article which suggests that in time of war, a nuclear power station would greatly increase the effect of a nuclear weapon if it should explode directly on the

plant site. The authors of this article have omitted two serious points. Firstly, in order to maximise immediate damage, a thermonuclear weapon would be exploded at some altitude, and it is highly unlikely that an intercontinental ballistic missile could be aimed so accurately that a reactor building could be at the explosion's epicentre. If it were any distance away it would be hard for the containment and pressure vessel to be concurrently breached. Secondly, in giving sole consideration to nuclear reactors they have ignored the effects of a nuclear explosion on less robust industrial plants which happen, as mentioned earlier, to be located much closer to large centres of population. Both of these points also apply to a non-nuclear attack. The containment shells of modern power reactors are designed to withstand the impact of airliners, and are considerably more robust than the German submarine bunkers which withstood direct hits from Allied blockbuster bombs.

One remaining misconception in this area needs to be cleared up, perpetuated by none other than the Flowers Commission in 1976. While they grudgingly concede that the threat of conventional air attack exists and should likewise be weighed in the non-nuclear fields, they added that: "The unique aspect of nuclear installations is that the effects of radioactive contamination are so long lasting." They have ignored the fact that chemical toxins have a "half-life" which is infinite - something worth remembering when nuclear opponents engage in the 'future generations' gambit when discussing nuclear waste. Incidentally, Mr Sampson's assertion that "a technology for the disposal of the highly active fission products in the waste has not even been developed" is also untrue. There is copious scientific literature on methods of highly active waste disposal which render it far less damaging to the environment than the waste currently produced by coalfired plants. What I find most alarming about Mr Sampson's article is his conclusion, namely, that having come to the end of a long list of horror fantasies about the safety of nuclear power, he thinks there is no clear case for abandoning it. I can only surmise from this that he cares a good deal less about the sanctity of human life than I do. If nuclear energy really posed all the threats which he alleges, I would quickly turn against it. Now if Mr Sampson believes all he has writtten, yet still maintains that we should not abandon nuclear power outright, 1 am forced to ask what kind of technology would turn him off - atmospheric H-bomb testing in Trafalgar Square?

The anti-nuclear lobby as a whole would show themselves in a much more sympathetic light if only they would use the same yardstick to assess the risks of all alternative energy sources, instead of quietly ignoring the dangers of those in which they are not interested. 1 mentioned the casualties of some non-nuclear accidents in my last article, and also pointed out that, to date, nobody in the Western world had died in the operation of a commercial nuclear power station. Mr Sampson duly took no notice. Although such tactics will never be able to stop the growth of nuclear energy, they have proven effective in delaying it.

And the longer it is delayed, the longer people will go on dying from manifestly less safe power sources.

References:

1. See table 1 in M. Levenson and F. Rahn: "Realistic Estimates of the Consequences of Nuclear Accidents". *EPRI, Palo Alto,* California 94303.
2. Fetter S.A. and Taipis K. "Catastrophic Releases of Radioactivity." *Scientific American*, April 1981.
3. Royal Commission on Environmental Pollution, *HMSO, 1976.* Para 315.
4. The literature in this field is enormous, but see. 'The disposal of Radioactive Wastes from Fission Reactors.' B.L. Cohen, *Scientific American*, June 1977. Also 'The Management of High Level Waste and its Enviromental Impact." J. Saunders, in *"The Environmental Impact of Nuclear Power,"* BNES, 1981.