K. Selgrade of the Environmental Protection Agency in Research Triangle Park, NC. However, the new data are prodding the agency to develop standardized assays so that microbial-pesticide developers can rank the relative allergenicity of their products. Indeed, Selgrade notes, if what makes Bt allergenic is not what makes it pesticidal, developers might one day genetically manipulate Bt to make it less worrisome.

2. Tabashnik, B. E., ibid, 3488–3490.


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NEWS

Chernobyl to shut-down*!

According to an announcement made on 6 June 2000, the Chernobyl nuclear power station, scene of the world’s worst nuclear accident, is to be shut down before the end of the year. Chernobyl is expected to be shut down totally, 14 years after the world’s biggest nuclear disaster; lying bare and empty, the site that faced huge evacuation is now a mute spectator to the persistent effects of the explosion 14 years ago. The plant is still generating power. The workers are confident that the plant would never again pose a threat. Hence the news of its shut down is somewhat surprising and sombre. On the plant getting shut down, there will be loss of jobs but more importantly, the radioactive by-products of the explosion will remain dangerously confined for hundreds of thousands of years. The most obvious worry is the concrete sarcophagus (see Figure 1) which entombs reactor number four, the one which exploded. It was intended to contain the radioactive debris in an impenetrable shroud, and to prevent any contamination leaking into the environment. However, the sarcophagus is already crumbling. If Chernobyl is ever to be safe, it will have to be rebuilt or replaced, at immense cost. Another concern is the type of reactor installed at Chernobyl. The Soviet-designed RBMK is said to be an inherently unsafe design. But there are many other similar reactors operating across much of eastern and central Europe. The RBMK has what is known as ‘a positive void coefficient’, which in lay terms means that it has a tendency in certain circumstances to run out of control. Modern Western reactors, by contrast, have a negative void coefficient, and tend to shut themselves down unless the operators override them. And a final worry, as per BBC News’ Online’s Environment correspondent Alex Kirby is ‘despite the brave hopes of the Chernobyl workers who talked to me, it is the legacy of Soviet safety culture itself. However prudent individuals may have been, there was a tendency to believe in the invincibility of the state’s technology. There was an unwillingness to accept just how great the potential was for things to go wrong – not that the nuclear industry in the rest of the world is immune to similar delusions’. With RBMKs still operating at other sites, that potential remains.

What happened at Chernobyl? The power station, 110 km north of the Ukrainian capital Kiev, was the scene of the world’s worst nuclear accident on 26 April 1986. Reactor number Four at the Chernobyl nuclear power plant began to fail in the early hours of that fateful day. Seven seconds after the operators activated the 20-second shut down system, there was a power surge. The chemical explosions that followed were so powerful that they blew the 1000 ton cover off the top of the reactor. Following the explosion, radioactivity, equivalent to what could be released by several hundred atomic bombs of the type that destroyed Hiroshima, was released in the form of a radioactive cloud across much of Europe. The radioactivity could be measured in the atmosphere in far away Sweden and beyond within a few hours.

Design flaws in the power station’s cooling system probably caused the uncontrollable power surge that led to Chernobyl’s destruction. Serious mistakes had also been made by the plant operators, who had disengaged several safety and cooling systems and taken other unauthorised actions during tests of electrical equipment. With procedures intended to ensure safe working of the plant operating less than effectively, the Chernobyl unit was vulnerable to unforeseen power discharges. The Chernobyl plant did not have an effective containment structure, and without that protection, radioactive material escaped into the wider environment.

The crippled reactor is still encased in the hurriedly constructed concrete sarcophagus, which is growing weaker as already stated. But as power sources in Ukraine are scarce, although three of

*This write up is based on information culled and edited from a number of web-sites principally related to or linked to http://news.bbc.co.uk. Several sites currently exist which describe the sequence of Chernobyl events and the effects on the offsite communities and environment. One has to be cautious as some of them, unfortunately, misrepresent the events, reasons, and consequences. Several sources listed in the website {http://www.cannon.net/~gonyeau/nuclear/chernobyl/btn.html} are believed to provide the most factual information.
Chernobyl’s four reactors are now permanently shut down, one reactor (reactor number three) has continued to be used to produce electricity. It underwent long repairs last year, but has malfunctioned several times. The accident, in addition to the deaths of some 2,500 people (according to the Head of the Ukrainian Radiological Studies Centre, Viktor Poyarkov), has affected millions and displaced hundreds of thousands, many of whom have still not been able to return to their homes. Within the existing concrete casing lie about 200 tons of highly radioactive dust and melted nuclear fuel and debris. The risk of radioactive dust escaping into the surrounding atmosphere, or of highly contaminated water seeping into the national water supply is high. There are fears that the concrete sarcophagus could collapse, causing another plume of radioactive dust to contaminate the surrounding countryside in Belarus, but that 40% spread to other nearby areas, including Ukraine. Immediately after the accident, the main health concern involved levels of radio-iodine radiation. Nearly 600,000 workers were involved in the recovery and clean-up after the accident and they were exposed to high doses of radiation. The exact amount of radiation exposure could not be accurately measured. But estimates of about 165 millisiverts have been made. Doses of radiation above 10 millisiverts pose significant threats to the human body. Soviet authorities started evacuating people from the area around Chernobyl within 36 h of the accident. It is estimated that five million people were exposed to radiation. A month later, all those living within a 30 km radius of the plant – about 116,000 people – had been relocated.

Several international organizations have studied the environmental and health impacts: Chernobyl toll – 31 killed immediately; 15,000 relief workers killed subsequently; 50,000 relief workers invalid; 5 million exposed to radiation in Ukraine, Belarus and Russia; 52,000 fled the area. The World Health Organization says that, so far, there has been a large increase in thyroid cancer among children in the affected areas.

According to UN data cited by the International Atomic Energy Agency (IAEA) in June 2000, the Chernobyl accident had less impact on public health than was initially feared. About 1,800 children did develop thyroid cancer, a treatable disease which is rarely fatal, and more cases are expected, as per the IAEA statement. However, with this exception, there is no scientific evidence of increases in overall cancer incidence or mortality or in non-malignant disorders that could be related to radiation exposure,” it said. Hence the precise impact of the Chernobyl disaster has always been disputed.

The following scenario has remained a matter of concern: After the dissolution of the Soviet Union, Russia and its former Soviet neighbours were left to deal with the legacy of the Soviet nuclear programme. Warheads, decaying submarines to radioactive lakes are a part of the scenario. The leaking and unstable concrete sarcophagus at Chernobyl prompts fears of another nuclear disaster. As far as the Soviet nuclear history is concerned, this is not the only case to worry about. Accidents at a secret plant at Mayak releasing vast amounts of radioactive waste into a lake and an explosion at Tomsk in Siberia in April 1993 where several tonnes of uranium and plutonium salts were said to be scattered over the surrounding countryside can be mentioned in this context. The Russian nuclear facilities have faced serious economic problems which have had direct effects on their safety. There have been drastic cuts in the defence budget. Heavy industry and other electricity consumers do not or cannot always pay for the electricity the nuclear power stations deliver. This means that the operators at the stations can go months without being paid, and general maintenance becomes neglected. There have been other aspects concerning rusting submarine fleet in the north of the country and other nuclear waste, comprising fuel elements, reactor cores and large amounts of solid-fuel nuclear waste. Environmental groups say that the Russian nuclear industry has not managed to address the question of nu-
clear waste disposal in general. Storage facilities for radioactive waste and used fuel elements are believed to be filled to capacity at a large number of nuclear power stations in Russia.

Western countries have been demanding the closure of the Chernobyl plant. The European Union and Group of Seven industrialized nations undertook in 1995 to find a safer and more permanent form of protection for the ruined reactor. The Ukrainian Government agreed earlier to shut the site but it depended on the country getting international aid. This pledge to close the Chernobyl reactor came after years of wrangling about the details of a compensation package to be provided by Western governments. Ukraine has been seeking money to decommision the Chernobyl plant and bring two new generating plants on stream. The promise to close the power station in 1995 in exchange for aid from the G7 group of industrialized nations, has been repeatedly delayed saying it had not received the money. The package of aid from G7 countries to Ukraine, in grants and loans, was worth a total of about $3 billion. Ukraine failed to close the plant by the deadline at the end of 1999, and threatened to continue operation until the end of the plant’s natural life in several years’ time. One of the key elements of the Chernobyl closure compensation package – work to make safe the shelter around the stricken fourth reactor – has gone more smoothly. An unstable chimney towering above the reactor was stabilized in 1998. Some of the beams inside the shelter were reinforced in 1999. As of January 2000, the European Union and 25 other countries had committed nearly $600 million of the $768 million that the work on the shelter is expected to cost. The rest of the money is still being sought. Among the next steps planned are efforts to limit the contamination that would result – because of earthquake, accident or extreme weather – if the shelter were to collapse. Once the project has been completed, in 2005, it is envisaged that the sarcophagus will remain safe for another 50 to 100 years. By this time the outlines of the final solution should also have been sketched. Ideas proposed so far include constructing a hermetically sealed dome over the existing plant, or, more ambitiously, removing the radioactive debris and returning Chernobyl to a green field site.

The 6 June 2000 announcement has stated that the damaged Chernobyl nuclear power station is to close permanently in December. The news was announced in a joint statement issued by US President Bill Clinton and the Ukrainian President Leonid Kuchma, during Clinton’s brief visit to Kiev. The closure pledge given by Kuchma in the presence of Clinton is reported to be unconditional. The American president hailed it as an ‘historic announcement’ and said that the US would provide $78 million to help contain radiation from the destroyed reactor. Kuchma said it had not been an easy decision to agree to close Chernobyl but it was a logical one. ‘The aim of this decision is to reduce nuclear risks in the world,’ Kuchma said. Clinton is said to have undertaken to ask the G7 for assistance in shouldering the costs. The US will also provide a further $2 million for safety measures at other nuclear power plants in Ukraine.

On 4 July 2000 Western donors from more than forty countries gathered in Berlin to discuss ways to help increase safety at the Chernobyl plant. At the end of two days of meeting, they have pledged an extra $370 m to make safe the Chernobyl nuclear reactor. This brings to $715 m the fund pledged by international governments for the urgent repairs to sarcophagus, close to the sum Ukraine needs for the repairs.

Although Chernobyl remains unfortunately the most severe civil nuclear disaster caused by a combination of human and design issues, it may not be the last. There are currently 430 commercial nuclear power reactors operating world-wide. Ten years after the Chernobyl accident, the world has yet to meet the challenge head on of mastering the most complex and dangerous energy source yet devised by humankind, namely, nuclear power. The Chernobyl event represents the extreme case where a substantial portion of the fission products in the reactor core and some of the fuel were released directly to the environment. It also represents the first time that nuclear process-related deaths occurred at a commercial nuclear power facility and the offsite public was affected by events at a plant. Chernobyl’s closure is inevitable and probably overdue.

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Silicon devices with biological functions

The next time you need to spot a relative, or a friend on a railway platform, think of what functions your brain has to perform. It has the enviable task of identifying one particular individual, amongst an otherwise continuous multitude of humanity available in the field of vision. Talking in terms of electronic circuits, these are incompatible functions. If identification of the particular individual corresponds to the state 0 or 1 of a digital circuit, which is by definition a nonlinear operation, the signal from the general background of people is akin to an analogue response. The neuronal circuits of the neocortex do not respect this distinction. A question naturally arises – is it possible to train an electronic device to do the same?

In a recent publication in *Nature*, researchers from ETH, Zurich, Bell Laboratories, New Jersey and MIT, Massachusetts have shown an alternate way to build a silicon device modeled on biology. Each neuron is represented by an electronic circuit, whose status is active when the circuit produces an output current, while inactive otherwise. No negative current values are possible. A total of 16 such active circuits, representing neurons, are placed together in a ring. Each neuron makes a (synaptic) connection of variable strength onto