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Nuclear power

Chernobyl 1986: when nuclear power came of age

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30 years ago, at 1.23 am on the morning of 26 April 1986 the number 4 reactor at the Chernobyl nuclear generating site near Pripyat in Ukraine went on SCRAM alert. Within 3 seconds all of the reactors safety systems had failed and with control rods jamming the reactor core, the temperature rose by 10 times its design level. The resulting first explosion destroyed the 2,000 tonne concrete containment plate and blasted it clear of the reactor building. And it was in that instant that station operator Valery Khodemachuk, his body impaled on control rods, became the first Pharaoh of the nuclear age, entombed in a sarcophagus even taller than the great pyramid of Giza and for the eternity required for the radiation to recede to safe levels.

Brian Parkin recalls the Chernobyl disaster and explains how what is always explained away as a â€˜one off' event demonstrated the lethal combination of technical arrogance, corporate and state deceit and human fallibility that will forever lie at the heart of the myth of nuclear power.

Hard rain

The 1986 Leeds May Day demonstration was always going to be a muted affair, coming as it did just 12 months after the historic defeat of the miners. But for me it was memorable in one respect: it rained. Later on that afternoon a post-graduate friend of mine rang and asked if we had got wet on our outing, “because if you did you will have got some caesium-137 thanks to the Ukraine nuclear disaster”. Earlier, as a routine task of monitoring overnight rainfall at a Leeds University weather station, he had found clear traces of the radioactive isotope.

Within days, as even the secretive Soviet state couldn't suppress the truth, it was clear that a major explosion at a nuclear station in Ukraine had spewed much of the contents of a shattered and burning reactor into the outside atmosphere. And borne upwards by easterly spring winds, fall-out in the form of isotopes of caesium, iodine and xenon had blown across much of Europe.

Critical times

The international nuclear industry, under the auspices of the International Atomic Energy Agency, has proved over some 50 years to be an effective watchdog and regulator of all matters regarding nuclear power. It has also undertaken the role of ensuring a uniformity of secrecy and deceit as far as matters of safety are concerned- particularly in the immediate aftermath of a major nuclear â€˜incident'. But with Chernobyl in April to May 1986, the â€˜incident' was of such a massive scale that any amount of cover-up was bound to fail.

During the 24 hours preceding the accident at Chernobyl, the operating staff had been engaged in authorised part-load running experiments in order to improve reactor efficiencies. One problem they were attempting to deal with was the build-up of a reactor â€˜poisoning' isotope- xenon-135- that tended to slow down the reactor neutron speeds when the plant was operating at reduced load.

The â€˜experiment' involved trying to maintain reactor stability and preventing xenon formation by varying the time

span of control rod insertion. This was being done manually when the reactor temperature first fell and then suddenly surged. The consequent massive peak in temperature and the pace of the run-away reaction overwhelmed both the manual and automatic control rod processes.

At 1.23 am an emergency SCRAM state was automatically tripped as the core temperature soared with only 28 out of 211 control rods in place. Within 30 seconds 18 out of those 28 had fractured due to the heat. It was at this stage that the first steam explosion occurred as the steam discharging from the broken fuel channels instantly and massively expanded, ripping the reactor structure apart, shattering the inner containment and blasting the upper containment plate through the roof.

Graphite fire

The Russian RBMK reactor like many designs worldwide, and including all of the UK's reactor fleet in 1986, was based on a graphite core through which the fuel and control rods were passed in channels. But the problem with graphite, although it can â€˜moderate' the speed at which reaction neutrons move, is that, like coal, it is around 90% carbon in content. Consequently, when the 10,000 degrees Celsius core was blasted open to the outside atmosphere, the oxygen in the air instantly reacted with the red-hot graphite and started to burn fiercely. (This led to the rather tasteless joke at the time that Chernobyl was the world's first ever coal fired nuclear disaster).

An initial a steam explosion was followed by a hydrogen explosion with a simultaneous graphite core fire – all within seconds. The power station staff were completely overwhelmed. Which is when a collective act of the most tremendous heroism took place. Fully aware, as they must have been, that they were already fatally irradiated, the 30 reactor workers dosed themselves with potassium iodine tablets, donned respirators and decontamination suits and entered what remained of the upper reactor level in a bid to supress the fire. Although later rescued from the building, they all died in lead-clad hospital isolation units within the next 24 hours.

As they tried to cope with the effects of the second explosion, a third â€˜runaway criticality' explosion occurred, which was effectively the kind of explosion associated with a nuclear weapon. This explosion effectively removed most of reactor 4's upper building and set fire to the reactor 3 building's roof.

Collateral damage

The fires at Chernobyl raged for 14 days. During this time teams of local miners were drafted in to mine under the blazing reactor in order to get concrete ballast under the foundations and prevent a core melt-down into the water table. Thousands of volunteer â€˜bio-robots' were drafted into the station complex and it has been estimated that some 500,000 such workers were were rationed to a maximum 40 seconds of work near the reactor – during which time they are thought to have recieved over 50 lifetimes of safe lifetime radiation.

Around Pripyat itself, 53,000 were immediately evacuated, forever. And although the International Journal of Cancer estimated around 4000 deaths in Ukraine from the accident, a further 4000 â€˜excess' cancer deaths were estimated for the neighbouring Belarus region. Greenpeace has estimated over 200,000 excess cancer deaths in Ukraine and surrounding regions for the ten year period following the reactor explosion.

Overwhelmed

The reactor type at Chernobyl 4 was a tried-and-tested design, common throughout much of the former Soviet Union and Eastern Europe. Based on a graphite moderator core, this was a material choice common among nuclear power countries and in particular, in the UK where all the Magnox and AGR stations operating at the time of Chernobyl were graphite moderated, albeit gas cooled.

Many of the problems associated with graphite block constructed cores, particularly radial cracking around the fuel and control rod channel pathways, have manifested themselves on all of the 8 AGR stations in the UK. Most of these are licenced to run for at least another 10 years.

The second-by-second cooling requirements of a Chernobyl type and size of reactor are formidable. Each reactor core has 1,600 fuel rod channels, each of which requires a constant flow of 28 metric tonnes of water per hour. It was estimated that a 30 second cooling water failure at Chernobyl would result in a fire. When the cooling water supply began to fail as the pumps were denied power from the reactor, the diesel power took over 75 seconds to come online, by which time the core was alight.

So sequentially every safety system went down, leaving a desperate reactor crew in their dying moments to bring the core under control by trying to manhandle control rods into already blocked control channels.

Circles of Hell

Chernobyl was the first ever level 7 nuclear event- only to be surpassed by the Fukushima events of 2011. But the two events, where there were repeated safety system failures in split-second sequences, were the stuff that any future nuclear catastrophe will be made of. When human fallibility in turn becomes a technological hubris that in turn is applied to energy processes hotter than our very Sun, with the addition of power production for profit, the worst can – and will – happen.

The nuclear age’s Pharaoh, Valery Khodemachuk is about to get a new sarcophagus. The original one constructed between 1987-89 has long since begun to fall apart. But with the assistance of the European Bank of Development and Reconstruction, he is about to get another one. All for the cost of â‚¬2.15 billion. It is intended to last for 100 years, compared to the pyramids of ancient Egypt that have lasted 6,000 years. And the half-life of some of Chernobyl’s isotopes is beyond 180,000 years- longer than the human span on Earth.

For the sake of both sanity and humanity, the deadly alchemy of nuclear fission must be struck out for ever from our range of energy options. We have been warned.