

ARTICLES

The Causes of The Chernobyl Event

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The number 4 Chernobyl reactor suffered a power excursion on April 26, 1986 during a low power test. The power increased to about 100 times its nominal value: the reactor was destroyed by a steam explosion and 12 exabequerels of radioactive isotopes were injected into the atmosphere contaminating an area of about 60 000 sq miles inhabited by 6 millions people and causing a measurable increase in the level of ionizing radiation in most of Europe.

This event had two components: the **explosion** and **the effects** on public health. We will examine them separately and discover that both were mostly avoidable.

The two major civilian nuclear accidents before Chernobyl - WINDSCALE (1957) in the UK and TMI (1979) in the United States - caused no deaths.

The 1000 Megawatt-electric RBMK reactor is graphite-moderated and light water cooled. In addition to electrical power, it produces weapons-grade plutonium-239. The Chernobyl power station was a major source of energy for the Ukrainian SSR

THE CAUSES OF THE EXPLOSION were of three types: (1) **design** weaknesses, (2) management **faults** and operating staff **errors** and (3) **political** causes.

Regarding **design**, the **RBMK** reactor suffers 5 major weaknesses: core instability at low power which means that the reactor is then difficult to control and any tendency toward a runaway chain reaction is automatically and rapidly amplified; insertion of control rods is very slow and when the control rod is inserted its graphite tip first increases the reactivity before reducing it; these reactors are not protected by a system to filter exhaust gases nor by a containment structure; and finally hot graphite bursts into flames when it comes into contact with the atmosphere and vaporizes radio-isotopes dispersing them in the air. Russian nuclear engineers knew of this instability as did French and British experts. The Soviet authorities were warned well before the Chernobyl accident, but the warning fell on deaf ears. None of these 5 design weaknesses exist in western light water reactors (PWRs and BWRs) nor in Soviet VVER (PWRs).

Management faults were mostly a criminal lack of adequate training of the operators, inadequate permanent operating procedures, lack of enforcement of the rules and incomplete and imprecise instructions for this delicate low power test.

These management weaknesses led to at least **six human errors** committed by the operators. Two permanent operating rules were violated: not to run the reactor for any length of time at reduced power level, and never to have fewer than thirty control rods fully inserted into the core. One error consisted in not following the test procedure, and three safety mechanisms were deliberately bypassed - one for emergency water injection, and two others for emergency shut-down. It is clear that operators were not able to appreciate the implications of their acts

Turning to **political causes**: in the Cold War the plutonium production aspect of the RBMK imposed a sense of urgency on their design, construction and operation; no time and no funds were to be "wasted" on improvements however essential to a safe operation. The scientists and engineers worked under one and only one guideline: to produce weapons-grade plutonium as much as possible and as quickly as possible.

It was under these circumstances that the Minister of Electrification declared at a Politburo meeting on May 2, 1986, six days after the explosion: "In spite of the accident, the construction team will meet its socialist obligations and soon begin to build reactor number 5."

The culture of secrecy, universal in the USSR until 1989, imposed compartmentalization of knowledge: no single person was allowed to see the big picture and to integrate all aspects of the safety of the operation.

Some Soviet scientists were strictly honest. Others, just as competent, were motivated first by their personal interests and lacked the courage to be scientifically rigorous. Without scientific debate they accepted certain questionable decisions made by the political authorities.

The design weaknesses arise from Bureaucratic dictatorship, not from engineering incompetence.

It is clear that the explosion of the Chernobyl reactor was made possible by the many shortcomings of the Soviet system. One may well say that the Chernobyl explosion was more a Soviet event than a nuclear event.)

Before looking at **THE CAUSES OF HARMFUL EFFECTS TO HEALTH** let us stress that, apart from the death of two persons present atop the reactor when it exploded, these effects were not inevitable. But circumstances were such that, due to **immediate** and **deeper causes**, there were harmful effects to public health which we first summarize below.

Much controversy surrounds the magnitude of these effect, too often with a lack of scientific rigour. In the interest of objectivity we refer to the **UNSCEAR** (United Nations Scientific Committee for Effects of Atomic Radiations) report of June 6, 2000. Paragraph 136 reads as follows: "Apart from the increase in thyroid cancer after childhood exposure, there is no evidence of a major public health impact 14 years after the Chernobyl accident. No increases in overall cancer incidence or mortality have been observed that could be attributed to ionising radiation. The risk of leukaemia, one of the main concerns (leukaemia is the first cancer to appear after radiation exposure owing to its short latency time), is not elevated, even among the recovery workers. Neither is there any scientific proof of other non-malignant disorders, somatic or mental, that are related to ionising radiation."

We note that **UNSCEAR**'s conclusions are consistent with observations made since 1945 on 86 500 survivors of the atomic bomb attacks on Hiroshima and Nagasaki.

We recall the following data which characterize the harmful effects to public health due to Chernobyl. They concern an area of 60 000 square miles around Chernobyl, in Belarus, Ukraine and the Russian Federation: 2 operators were killed by the explosion; among 134 persons acutely irradiated, 28 persons died in the 3 months following the accident; up to the beginning of the year 2000, about 1800 cases of thyroid cancer had been reported among persons who were under 18 in 1986 with a very low mortality of about 10 deaths. New cases are expected in the coming years. No excess of solid cancers nor of leukaemia nor of congenital anomalies have been reported. By far the greatest harm - but there are no available figures - is found as suicide and violent death among the firemen, policemen, other recovery workers (officially 313 000 recovery workers) on the site and among the evacuated population who suffered a considerable reduction in the quality of their life.

There is no evidence of any effects to public health outside USSR. One might say that the real victims were an estimated 100 000 fetuses unnecessarily aborted in panic in central and eastern Europe because the pregnant women and medical personnel - midwives and physicians - fell prey to an exaggeration of the effects of radioactive fallout. "

The **immediate cause** of harmful health effects was the absence of an emergency plan. The public was kept in the dark. Instructions to stay indoors with windows and doors closed were not issued for 36 hours. A ban on the consumption of fresh milk and locally produced fresh fruit and vegetables was not issued for seven days. There was no provision for the immediate distribution of stable iodine to prevent thyroid cancers, nor was protective clothing available for the firemen, operating personnel and recovery workers.

The deeper causes of harmful health effects are political: the elementary precautions mentioned above were not taken because the authorities and the power station management did not know that they were needed. They had no emergency plan, no medical supplies, no protective clothing, not even instruments to measure radioactivity. Yet several murderous military nuclear accidents, which occurred as early as the 1950s (e.g. Mayak and others) causing 433 deaths by acute irradiation, had led Soviet scientists and physicians to develop suitable techniques for radio-protection and care. The useful recommendations they made early on to USSR authorities were ignored. For example the radio-protective substance "Preparation B" was ready by the mid-1970s but the program not implemented!! Similarly, Soviet biologists knew how radioactive iodine was fixed on the thyroid and knew the protective power of stable iodine. As far as back the 1970s they also knew how to protect against radio-caesium and radio-strontium. Due to the heavy administrative procedures, budgetary difficulties and political-scientific quarrels, none of these defensive measures, and in particular neither "Preparation B" nor potassium iodide, was available at Chernobyl in 1986!!

Let us finally remark that an efficient emergency plan providing for the simple and effective measures mentioned above was approved by the USSR Minister of Health in December 1970, but it remained a dead letter. A new plan, presented in 1985, was refused because an accident justifying such measures was "impossible in USSR".

The great breadth and depth of relevant knowledge developed by Soviet scientists was not made known to the medical and nuclear communities of the Soviet Union. Local civilian authorities either knew nothing of it or paid no attention to it. Ignorance and lack of preparation were so profound that in the wake of the explosion the vast majority of the actors in the drama: reactor operating crews, directors of the power station, local and higher authorities were so distraught that they were unable to appreciate the dimension of the disaster, unable to define priorities and unable to undertake even the most urgently required activities.

- **Thus it was** that the 28 deaths of rescue workers could have undoubtedly and easily been avoided.

- **Thus it was** that the population of Pripjat, 2 to 3 miles away from the power station, were not informed and evacuated until the afternoon of April 27, more than 36 hours after the explosion.

- **Thus it was**, conversely, that the evacuation of 120 000 persons, decided later in spring 1986, was not proven justified for lack of measuring instruments while it led to numerous suicides and violent deaths.

- **Thus it was** that tablets of potassium iodide were not distributed to the exposed population, or were distributed too late to be effective. Those tablets would have protected their thyroid glands from irradiation by radio-iodine and thus prevented cancer: it is clear that the 1800 cases of cancer among young people could have been easily avoided. It is worth noting that stable iodine was indeed distributed in neighbouring Poland and, as a result, that country has not had any excess of juvenile thyroid cancers.

- **Thus it was** that the offer of the USA on May 1st, five days after the explosion, to send a great quantity of stable iodine as sodium iodide tablets was declined.

- **Thus it was** that only on May 2, seven days after the explosion, the consumption of local agricultural products was forbidden.
- **Thus it was** that the uninformed, misinformed and disinformed population fell prey to fear, and soon realized that the public authorities had lost control of the situation.
- **Thus it was** that the people became the victims of tales and rumours which were, and still are today, the bread and butter of the "merchants of fear" who inhabit the local, regional, national and international press.
- **Thus it was** that many of the recovery workers and evacuees fell victim to psychological stress; in addition to many suicides, the psychological trauma led to respiratory, digestive and cardio-vascular disease. These cases are not the direct result of irradiation but they constitute by far the greatest harmful effects to public health inflicted by the Chernobyl explosion.
- **Thus it was** that the political context of the Chernobyl accident made it impossible to avoid a considerable amount of harm to public health; this despite the fact that medical knowledge and preventive and curative techniques had existed for years and years in the Soviet Union whose scientists, engineers and doctors were as competent as those in the Western world.

Here again, one may well say that the health aspects of the Chernobyl event were much more a Soviet event than a nuclear event.

*As a **CONCLUSION** let us say that the Chernobyl disaster was made possible by a **political system** which accepted a lack of a culture of safety at three levels: reactor design, reactor operation and plan of action in case of a serious accident.*

With Western assistance, the RBMK reactor design, operating procedures and training of operators have been progressively improved since 1986. **Another explosion like that which occurred at Chernobyl is now extremely unlikely to occur at any of the 12 other RBMK reactors.** However, compared to the very high level of safety which the Western countries have insisted upon, the present situation is not totally acceptable: more improvement is still needed .

At long last, emergency plans to protect the population have been put in place in the ex-USSR, while before 1986 they were considered an unnecessary luxury.

The design errors of the RBMK reactor and especially the absence of a containment structure are unique to that model. Every other reactor in the world, including the recent Soviet PWR reactors (VVER 1000 and VVER 440 of the second generation), has a containment structure. Should the core suffer a meltdown, an extremely unlikely event, the containment structure would prevent the escape of dangerous radioactive substances. Successful containment was demonstrated at Three Mile Island in 1979. We may thus conclude **that a Chernobyl type event, an explosion destroying the reactor and its containment together with very serious consequences for public health and the environment, cannot possibly occur outside the ex-USSR and its former satellites.**

Let us not forget, however, that the Chernobyl reactor even as it was in 1986 would not have exploded if the operating crew, while faithfully executing a poorly defined and dangerous test procedure, had not deliberately bypassed several safety systems.

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A more complete version of this paper is to be found at <www.ecolo.org> the Internet site of the Association of Environmentalists For Nuclear Energy : Click on the Union Jack, click on documents, click on documents in English and look for Causes/Chernobyl/JF