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They didn't register us

To Vassily Deomidovich Dubodel, who passed away in August 1988,

and to all past and future victims of Chernobyl

They did not register us and our deaths were not linked to the accident.

No processions laid wreaths, no brass bands melted with grief.

They wrote us off as lingering stress, cunning genetic disorders...

But we are the payment for rapid progress, mere victims of someone else's sated afternoons

it wouldn't have been so annoying for us to die. had we known our death would help to avoid more fatal mistakes and halt replication of reckles deeds!

But thousands of 'competent' functionaries count our souls in percentages, their own honesty souls, long gone

So we suffocate with dispain they wrote us off.

They keep trying to write off our ailing truths with their sanctimonius lies.

But nothing will silence us even after death, from our graves we will appeal to your conscience not to transform the Earth into a Sarcophagus!

A Special

Issue on

Lyubov Sirota

ahead! Break some-

Goar Thinking

body's leg. You haven't caused him any harm.
After all, given time the victim can recover, and that according to the nuclear establishment (the International Atomic Energy Agency and the International Council for Radiological Protection), means that he has not suffered any "detriment" and hence he or she should not receive compensation for "bogus" complaints.

In their way of seeing things, any illness or damage done to the individual is not a "detriment" if the individual can recover with time. Thus, liquidators in the Soviet Union who received high radiation doses and whose blood counts are just beginning to become normal after suffering ten years of debilitating damage to the immune system, did not suffer. Similarly all those who suffer non-fatal cancers due to radiation do not have a detriment.

Only "severe" (another value judgement) genetic disease in live-born offspring is a detriment. Embryonic or fetal loss does not count neither do still—births or congenital malformations which are labelled by these worthies as non—severe and non—genetic. Death after the first two weeks of exposure to radiation, cannot be attributed to it. Nor can any death in which the victim did not have a verified acute radiation dose. No cancer can be attributed to radiation unless it has the approved latency period of ten years after exposure. Radiation promoted or accelarated diseases do not count.

Victims produce scientific paper after paper trying to prove the harm caused by radiation and hoping for their "acceptance" by the "recognised" authorities. These agencies just smile and stick to their value judgements. I mink we must begin to ridicule these value judgements rather than strain to keep proving the obvious. It has to be recognised that health effects of radiation are human rights issues They are not just technical or scientific issues.

Rasalie Bertell

From the Editor's

When Will They Ever Learn?

Chernobyl was a disaster, right? It definitely was so for the people. People suffered and are still suffering the consequences of the worst industrial disaster in history. People not only of Ukraine, Belarus and Russia, but even of distant lands where the winds blew and fire rained down. In these times of "free trade" and freer conscience, no place is really safe from the long lasting poisons disgorged by the accident.

But for some folks, the disaster at Chernobyl has been not a disaster but a marvellous opportunity to make more money and continue their power games. These folks are the guys in companies like Siemens, Framatome, GE, Wesunghouse, ABB and the like and their cronies sitting in government ministries all over the world but especially in countries with heavily centralised decision making.

The latest news on Chernobyl is that G7 and the European Union have signed a memorandum of understanding in which they have agreed to pay money to Ukraine to complete two unfinished Russian built reactors in exchange for shutting down the reactors at Chernobyl. Yuri Kostenko has been the Ukrainian minister in charge of the Chernobyl clean up and replacement power negotiations. He is also a candidate to become the director general of the International Atomic Energy Agency. No wonder, he finds nuclear energy as the cheapest and best option for Ukraine. Like some lepers in Indian cities exhibiting their sores to collect money these Ukrainian officials have been trying to extort huge amounts of money (two billion dollars every year for the next 20 years) by playing continuously on Western fears of Chernobyl.

It is indeed a wonder and a sad commentary on our times, that an accident which should have shut down nuclear industry world—wide has instead been used to support its revival, while the victims are left high and dry. What it shows is that how well the nuclear lobby is organised and how it has managed to control the debate Small, isolated antinuclear groups cannot fight this monster adequately. We need to recognise that nuclear industry is a global lobby which requires a global coordinated response.

In this issue we examine the various failures that led to the accident at Chernobyl and also the reaction of the authorities to the disaster and the myriad ways in which the accident was 'managed'. We compare the Chernobyl scenario with the present Indian nuclear scene. This is all the more relevant at a time when Indian political establishment is hoping to become a Santa Claus of the nuclear industry.

Some readers may find difficulty in comprehending the article "The Impossible Nuclear Explosion." It can be skipped on a first reading. We will supply interested readers who write to us the full text along with a glossary which might help in better understanding. However, its conclusions are important: firstly that the explosion at Chernobyl was a nuclear explosion and secondly that no containment in the world could have withstood it. This simple fact, that nuclear energy cannot be made safe by building bigger containment walls, has totally escaped not only the leaders of G7 and their Ukrainian counterparts but even supposedly hard-nosed bankers.

We are extremely sorry for the long delay in the publication of this issue.

5&6

The Reasons Why

In 1989 the Supreme Soviet of the USSR created a special commission to study the reasons of the Chernobyl accident and to examine the actions of authorities after the accident. Included in the commission were about two hundred experienced specialists from different branches of science from the three republics which suffered most from the Chernobyl accident (Belarus, Ukraine, Russia). Deputies of the Supreme Soviet of the USSR from these republics also took part in the activity of the commission. Expert subgroups studied 15 operating reactors of the RBMK' type at Leningrad, Smolensk, Kursk and Chernobyl nuclear power plants. They also collected, analyzed many materials possessed by different organizations and departments of different republics. Ordinarily these materials were not freely available and access to them was denied.

Conclusions of the experts

The primary cause of the accident was violations of rules of nuclear safety in design and construction of the reactor by scientific supervisor and Chief Designer of the station.

The main shortcomings of the reactor RBMK-l000 are:

- high positive void coefficient of reactivity;
- imperfect construction of rods of the reactor emergency system

The emergency situation in the case of the Chernobyl accident was aggravated due to low standards of the regulatory and technical documentation that could not provide adequate understanding to the operators of neutron and physical characteristics of the core of the reactor.

RBMK type reactors were in service since 1973. Several local emergency situations occurred: accident at block 1 of the Leningrad NPP in 1975 during which 14 fuel elements were destroyed; accident at block 1 of the Chernobyl NPP in 1982; failed critical starts of blocks 3 and 4 at the Chernobyl NPP 1981 and 1983 as well as failed critical start of the block 1 at the Ignalinskaya NPP in 1985. Adequate lessons were not learnt from these situations and the shortcomings they highlighted were not corrected.

As can be seen from the above the most serious flaws which led to the disaster were systemic faults. The actions of the operators, (who perhaps because of their thousand years of reactor experience felt that nothing could possibly go wrong) precipitated the already present deficiencies of the system into a disaster However, the immediate reaction of the authorities as well as nucleocrats all oyer the world was to blame the operators.

A Litany of Lies

Lies about Chernobyl started long before Chernobyl became a household word. For a flavour, the following quotation from *Bulletin of the International Atomic Energy- Agency* (Volume 25 Number 2, June 1983)

"The design feature of having more than 1000 individual primary circuits increases the safety of the reactor system-a serious loss of coolant accident is practically impossible." The Safety of nuclear power plants in the Soviet Union is assured by a very wide spectrum of measures, the most important of which are:

- "High quality manufacture and installation of components
- "Checking of components at all stages
- "Development and realisation of ways of localising radioactivity released in case of an accident
- "Realisation of technical and organisational measures to ensure safety at all stages of construction and operation of nuclear power plants"

The accident at Chernobyl on April 26, 1986 demonstrated that all these statements were just plain lies. They had been made by authoritative scientists who were not supposed to be liars, but in their enthusiasm for the technology they got carried away.

A lie repeated often enough and with enough authority becomes the truth. India has no dearth of our own chhota Goebbels. Let us compare the above set of proven lies with what *"Nuclear Power and You"* a Department of Atomic Energy, Government of India publication has to say about the safety of Indian nuclear plants:

"With more than 70 reactor years experience behind us, we can modestly claim that our nuclear power plants offer the greatest possible safety measures on par with the best in the world. This is the result of the state of the art technology employed in design, manufacture and operation of Indian nuclear plants. Reactors are housed in double containment and provided with foolproof triple back-up systems. To guarantee almost no leakage of radioactive elements into the atmosphere."

Reality Check: Before Chernobyl, the Soviets had had more than a thousand years of reactor experience and not a mere seventy.

Finding Scapegoats

Twelve years alter Bhopal we have yet to apportion responsibility and punish anybody for the disaster. But then we are we. What about the Soviets? They did punish people and sentenced them to long prison terms. But this punishment was meted out only to the lowest rung: the operators. Even in the proletarian paradise, higher officials with contacts in the system escaped with light raps on the knuckles. Nuclear *biradari* from all over the world closed ranks under the aegis of International Atomic Energy Agency (IAEA) and helped in perpetuating the myth that the accident was due to the perversity of the operators.

The following is an account presented by Dr. P K Iyengar, ex-chairman Department of Atomic Energy, in a public lecture at Bangalore on October 8, 1990, that is fully four years after the Chernobyl accident and at a time when the above mentioned conclusions should have been known to him:

"The accident was the outcome of an amazingly large number of violations. A technical description of the accident scenario reads like a saga of repeated attempts by the reactor protective system to prevent the accident, each one foiled by the operator. A very brief discussion of the accident, giving only the basic essential parts, is as follows.

"The accident occurred during a test. This test was supposed to be done at a power level of about 800 MW. The RBMK reactor has a positive void coefficient below 600 MW, and so it is not supposed to operate in this range. The operator forgot to enter 'hold power' at 800 MW before power reduction. As a result power fell and went to very low power levels. Frantic attempts were made to prevent this. In the process, more and more control rods were drawn out a many trips were disabled. Finally the reactor was brought up to 200 MW, which is a forbidden zone. The test should not have been attempted in this zone, but the operators went ahead anyway. As part of the test they shut of steam to one of the turbines. This led to a rise in the Primary Heat Transport systems pressure and simultaneously to running down of the pumps connected to that loop. In this highly sensitive region, all these factors combine to give a resultant value for steam quality. In this case, it turned out to be more voidage (bubbles) in the steam. Since the void reactivity coefficient of RBMK is positive, this started introducing positive reactivity, and the reactor went prompt critical (in ordinary language exploded). The proposed test was not a routine test, but a special one attempted in an operating power reactor without proper planing".

Reading this account, one is struck dumb, not so much by the pig-hcadedness of the operators, but by the perversity of the system which allowed such expensive and dangerous plant in the hands of ill-trained and obdurate persons. And the second question that springs to mind is why was the test so important that it had to be conducted in an operating power reactor at the end of its fuel cycle when its inventory of hazardous radionuclides was the greatest?

Ready for all eventualities!

"Gennady Aleksandrovich and I have just been at block 4. It's an awful sight. There is a smell of burning and there is graphite lying around. Where does the graphite come from?"
The Minister turned to the director of the nuclear power station. "Bryukhanov, you reported that the radiation situation is normal. What is this graphite?"
"It is hard even to guess The graphite that we got for building the fifth block is all in place, whole. At first I thought that it was this graphite, but it is all in place. We can't therefore exclude an eruption from the reactor." '
"We can't measure radioactivity accurately", Shasharin explained. "We had one radiometer but it was buried somewhere."
"It is outrageous! Why does the station not have the necessary instruments?"
"The accident wasn't in the plan. The unthinkable has happened"

From Grigory Medvedev: Chernobylskaya tetrad 1989

A familiar Tale

The following account from *"The Legacy of Chernobyl"* by Zhores Medvedev does throw some light on the vexing questions raised above.

According to the Soviet report, Reactor No. 4 at Chernobyl, had begun operating in December 1983. But this is only partly true. The construction of the reactor and all its systems was completed by then and it was launched (made critical in Indian nucleocratic terminology) on 20 December 1983. In the Soviet Union 22 December is a day of celebration for the workers in the energy industry. (This is the day when the profession is given press publicity and awards and bonuses are announced.) There is usually a long .interval between the launch of a new reactor (which runs for a short while on much reduced power) and its full commercial operation. The schedule normally prescribes up to 6 months of tests and repairs. It often takes even longer to test all the systems.

For purely political reasons (which certainly have nothing to do with safety), the administrators, engineers, scientists, workers and operators engaged in running the tests of Unit 4 publicly undertook to reduce the time taken for the tests and to put the reactor into full commercial operation ahead of schedule. Such undertakings arc usually made under pressure from ministerial and Party officials.

Completing a project ahead of schedule is a rare event in Soviet industry and it brings enormous rewards and benefits. The Soviet report to the IAEA acknowledged that turbogenerator tests to use rotation energy had been done - and had failed - at Chernobyl before. The original tests had probably been done during the launching period between 20 December 1983 to March 1984, when they were much safer and when they could easily be repeated. The only way that the time allocated for testing a new reactor can be shortened is by reducing the number of tests and postponing some of them.

Certifying that a nuclear power station is ready to operate is not a single act. Each system most be tested and officially accepted by the administration of nuclear power station from the construction and assembly teams. During the trial of Chernobyl officials in 1987, it was admitted that reactor no. 4 had been cleared for operation, although the safety tests relating to the turbogenerator had failed. The trial was held in camera and the full text of the sentence was not published. But it seems obvious that the acceptance document was signed on the last day of 1983 under pressure, in order to be able to declare that the works planned for 1983 had been fulfilled. In the Soviet system of planning there are annual targets based on a calendar year. If the station head Bryukhanov had not signed the act on 31 December 1983, thousands of workers, engineers and his own superiors in the ministries and committees would have lost bonuses, awards and other extras.

It is now known that the experiment that was attempted on 25 April 1986 was part of the tests which had been left incomplete at the end of 1983 and beginning of 1984. According to the Soviet report on the accident, it had been found (probably in the tests during the launching period in 1984) that the inertia rotation of the turbogenerators was insufficient to provide high voltage current for long enough to fill the gap before the electricity from the diesel generators became available. It seems likely that the engineers responsible for the electrical parts of the project suggested some alterations to the magnetic-field regulator. It would take time to make the alterations but a promise had already been given that the time taken to do the introductory launching tests would be reduced. The people in charge probably made a simple but irresponsible decision -to postpone the tests until the next cycle.

This kind of practice is not unusual in Soviet industrial construction. Many industrial objects are accepted by the relevant government commission with a long list on incomplete elements and operations which the construction team promises to complete after the object has been officially licensed. If the commission takes a strict line and refuses to sign an act of acceptance, no one receives a bonus and basic salaries may be delayed. Everyone, including the government, is unhappy if the plan is registered as unfulfilled. The result is that it has become normal practice to accept as fully operational industrial objects that have not been completed to specification.

Using the inertial rotation of turbine rotors is an important safety device of RBMK systems. The three emergency diesel generators cannot be started instantly. Cold weather probably affects the time it takes to start diesel generators. For the Chernobyl generators, the specifications maintain that they require 15 seconds to switch on and a further 30—40 seconds to produce the en-

A Clear Conscience

"And since we couldn't do anything anyway, we had no problems with our conscience any more. If, for example, we were given an order to dig up the earth from the buildings to the fences: we just moved the fences and that was it Cleaning up just one part seemed like utter nonsense (as did the cleaning up of everything else while the power plant continued to spit out contamination), and so we simply decreased the measures of nonsense and started to fit our days in the categories of the comfort of this nonsense
Source: Tiit Tarlap Chernobyl 1986: Memoirs of an Estonian Cleanup Worker

ergy necessary to run the emergency pumps.

A 50-second gap in the circulation of cooling water through the core might be acceptable if large amounts of fission products have not accumulated in the reactor fuel. But fission products generate residual heat even in the shut down position. The problem is that RBMK-1000 is a system with on-load refuelling. In other words, individual fuel channels can be removed and replaced if necessary without shutting down the whole reactor. And this means that in a mature reactor, there are likely to be both fresh fuel channels and many that are approaching the end of their natural life and have accumulated fission products. The cooling system serves each channel individually. If the water pumps are stopped older fuel channels may overheat and sustain damage very quickly. Thus anything that interrupts the pumping of cooling water through the reactor core is very dangerous. The intention of the engineers to complete the work that should have been done before unit-4 was put into commercial operation and to provide the turbogenerators with an important safety device is perfectly understandable.

Of course. *it*

It is well known that in India—the land of honest politicians and the steel frame officials, such shenanigans as described above are just not possible. Thus, it is a great surprise to recall that when Dr. P K Iyengar himself was about to retire as the Chairman, Department of Atomic Energy, unit-1 of the Kakrapar Atomic Power Station, was commissioned in a hurry despite the fact that the Emergency Core Cooling System failed the mandatory tests before the unit became critical. (See *Anumukti* Volume 5 No. 6 June/July 1992). In fact Mr. K. Natarajan who was the Chief Engineer, (Instrumentation and Control) and a member of the Kakrapar Design Safety Committee had specifically written:

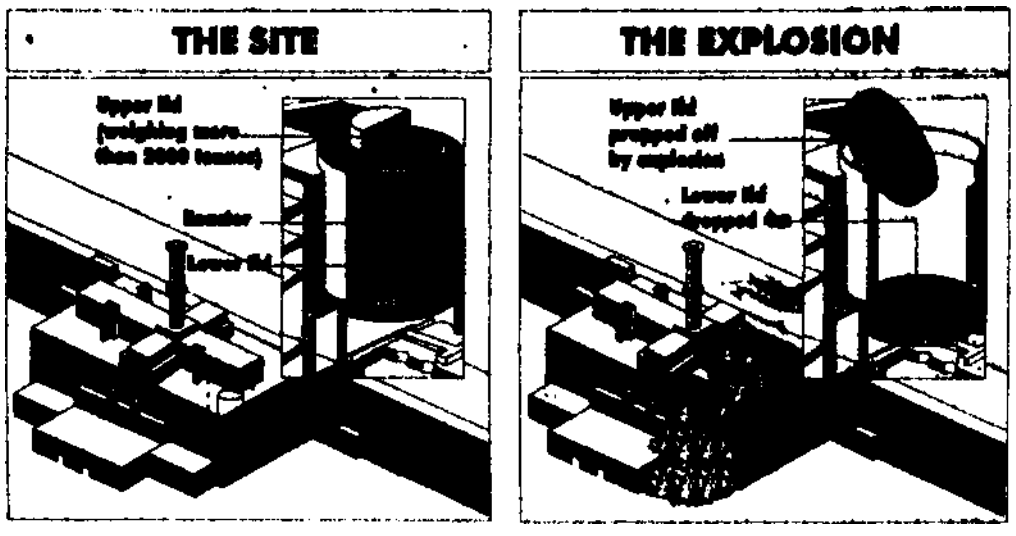
"The tests have been repeated and new operating points set. They are acceptable for KAPP-1 operation. However, a total integrated test with all the subsystems, components and logic functioning, should be done to confirm performance as per design intent in toto. *This must be done in KAPP-2 as soon as the system is ready and any retrofitting found necessary based on this test should be taken up for KAPP-1."*

At the time an annoynimous BARC scientist, who had sent this note to us, had written in his covering letter that:

"ECCS has no back-up system and it is hence essential that the system is fully tested before the reactor goes into operation. The integrated testing of ECCS is practically possible only once during the light water comissioning stage when the Primary heat transport (PHT) system is pressurised and heated up. Once the PHT system is filled with expensive heavy water, the integrated testing of ECCS is not possible since it involves light water injection into the PHT system. It becomes impossible once the reactor goes into operation and makes the PHT system highly radioactive, and misdeeds. This has almost become a culture in DAE." It is believed that actions by few top officials of this department who will be retiring shortly and hence would not be accountable for any future mishap are often responsible for irrational decisions"

After the accident the only people openly held responsible, were local plant officials and engineers. However, the government commission which must have been created to supervise the completion of the project, and which was obliged to check all the necessary tests before signing the licensing documents, must have consisted of competent high officials representing relevant branches of industry, the State Committee on Atomic Energy, the Ministry of Power, the Ministry of Medium Machine Building and officials of the fire protection services, representatives of ministries which manufacture turbogenerators, computer and control systems, representatives of the design bureaux and institutes which designed the project. One section of the commission would be people who had designed and built the project (they would have wanted an early completion date) and the other those who would operate it once it was tested and declared safe (they would normally want as little unfinished and untested work as possible to avoid future problems). If the relationship between the two was purely commercial, it would be impossible to cut too many corners or to cheat. But in the Soviet Union (as in India still) the groups represent different ministries but the same owner - the state. And it is normally state and party officials who try to find a compromise between the two groups. The compromise usually takes the form of an 'act of acceptance' which includes a list of incomplete tasks which the design and construction section promise to complete. All too often, however, the tasks are forgotten by the producers and must be completed by the consumers who were persuaded to accept the incomplete object, this is the rule throughout Soviet industry, from the building of apartment blocks or silage towers to the building of very sophisticated industrial projects.

The *impossible Nuclear Explosion?*



Schematic of the Damage Caused by the Explosion

Nucleocrats all over the world have repeatedly said that nuclear reactors cannot explode like nuclear bombs. This dictum has been repeated so often that even I had started believing in it. After Chernobyl a great deal of effort has been made to convey the impression that the explosion at Chernobyl was a steam explosion and a better Western type containment would have contained the damage. Below we present an analysis by D C Arnott and R D Green that clearly shows that there were two explosions and the second explosion was a nuclear explosion and that no containment in the world could have withstood it. In fact, the authors convincingly argue, that the fact that Chernobyl did not have a strong containment was a help, since the 2000 tonne concrete slab which covered the reactor core at Chernobyl and which was ejected during the first explosion, acted as a safety valve of a pressure cooker and thus prevented far more on-site damage from the second (nuclear) explosion,—Editor

Introduction:

In June 1990 an article appeared in *"Nuclear Technology"* called *"An Analysis of the Physical Causes of the Chernobyl Accident"*. The authors (Jose Martinez-Val et al of Madrid Polytechnic University Institute of Nuclear Fusion) cite results from extensive computer modelling based on the known Soviet data, from which the only conclusion consistent with scientific principles is that the primary cause of the destruction of Unit 4 on 26 April 1986 was a nuclear explosion. This contradicts the report of the British nuclear power establishment, which concluded that it was primarily a steam explosion. The Spanish analysis, drawing upon 46 published studies of the catastrophe, provides important evidence missing from the UK report. Also for the first time it unravels the mystery of why there were two explosions.

The official United Kingdom Atomic Energy Authority report on Chernobyl issued two years after the accident in 1988, was categorical on the point that the explosion at Chernobyl was not a nuclear explosion but a steam explosion.

"In essence, the Chernobyl accident was a steam explosion...triggered by a prompt-critical excursion. Responding to press reports that this amounted to a nuclear explosion, it goes to some lengths to deny such a possibility in any *reactor.*

The Chernobyl (RBMK) Reactor:

It will assist understanding of what follows if we begin with a brief description of the RBMK reactor design (see Fig.). This is additionally necessary because its radical differences from all other power reactors have led to misconceptions.

The core consists of a large assembly of graphite blocks which from the main moderator. This is vertically perforated by nearly 1900 tubes, most of which contain the fuel rods made of enriched Uranium oxide pellets clad in Zircaloy; whilst the remaining tubes contain the control rods.

Water, principally acting as coolant, flows upwards over the fuel rods, generating steam at the top of the core. The steam is fed directly to turbogenerators, after which it is condensed and recycled into the reactor. There is no secondary steam-raising circuit, tinlike the Pressurised Water Reactor (PWR). This defines the RBMK as one type of Boiling Water Reactor (BWR).

The fuel channels, also made of Zircaloy, are pressurised in order that the steam shall be hot enough for effective electricity generation. These channels also provide containment in the event of leakage of radioactivity from fuel cladding failure.

The rest of the core is enclosed in a leak-proof but unpressurised steel shell. Given the design, pressurisation of this shell is unnecessary. This has led to severe but misplaced criticism so important for our theme that it must be spelt out here. The misconception arises because UK thermal reactors are totally enclosed in pressure vessels which (like the RBMK fuel channels) also act as containment. But the pressure itself is not needed for containment: it is employed only because coolant, whether liquid or gas, extracts heat more efficiently when pressurised. However, loss of pressure in water coolant causes

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a phase change from liquid to gas, which drastically reduces its ability to absorb heat. This weakness played a major part in the destruction of Chernobyl Unit 4.

A final point, touching on the most difficult aspect of our analysis, will be helpful. It is that water is not only a coolant, it also absorbs neutrons and acts as a moderator. Loss of water in the RBMK, coupled with retention of the graphite moderator, thus contributed to the Chernobyl disaster.

It is estimated that about 1200 gigajoules of energy were released in Chernobyl eruption. 1200 gigajoules are equivalent to about 0.28 kilotons of TNT. That is more than the 0.25 kiloton yield of some warhead used in battlefield nuclear weapons. Thus the Chernobyl eruption was a tiny fizzle of a nuclear explosion in a device containing the potential fallout from roughly 100 Hiroshima and 100 Nagasaki.

Anatomy of An Eruption:

All accounts agree that about a second after Unit 4 went prompt critical, there were two explosions. The first involved a reactivity burst to about 100 times full power, which the analysis by Jose Martinez-Val et. al. of the Madrid Polytechnic University equates to a release of some 200 gigajoules of energy. Yet the prompt-critical excursion ended only after the second explosion, almost five times more powerful, had ruptured the fuel rods and dispersed enough of them by ejection upwards from the now-exposed core.

There is no dispute over what initiated the first explosion. As part of a mismanaged experiment, four of the eight main coolant pumps were shut down. The rapid fall in pressure caused water in the core to boil vigorously. Steam bubbles absorbed neutrons much less than did the water they displaced: with most control rods withdrawn to try to stabilise reactor power, the increase in neutrons raised reactivity: more steam resulted, and this "positive feedback" process caused a violent reactor runaway was checked only by the inherent Doppler Coefficient effect whereby, as fuel temperature rises, the neutrons available for fission are reduced, and with them reactor power. The Spanish analysis of what happened next:

"A few tenths of a second after the first power burst, the bulk of the energy (initially deposited in the fuel) was transferred to the water in a very fast, non-reversible process very similar to a steam explosion. The heat transmission rate from fuel to the coolant was so high that convective streams could not develop within the water. The steam film and bubbles produced (on) the (fuel cladding) surface grew and expanded much faster than the boiling of the bulk of the water. The internal pressure of the bubbles increased so rapidly that the water was suddenly expelled from the reactor. The 'dried-up' reactor was much more reactive than the wet one, and a second reactivity trip occurred...In any case, this second power burst was stopped only by the destruction of the reactor."

Clear evidence that the core was dry , before the second explosion can be found in Fig. IC following page 5.50 of the United Kingdom Atomic Energy Authority's (AEA) report.

Hence the first explosion occurred with the expulsion of water; while the second, which according to the Spanish analysis released about 1000 gigajoules of energy, was exclusively nuclear.

Attempted Refutation by Nuclear Authorities

The report brought out by UK Atomic Energy Authority (AEA) begins to try to justify its assertion that Chernobyl could not have been a nuclear explosion by describing a nuclear weapon-type explosion: "Weapons designers (achieve a nuclear explosion by) producing rapid increases in reactivity far beyond the 'prompt critical' state..In these circumstances the fission are due to fast neutrons, the time between successive fission is very short and massive amounts of energy are released before the material has time to blow itself apart and thus terminate the fission chain reaction."

It argues: "Such an event cannot happen in a thermal nuclear reactor..." (what is left unsaid is an implication that it can in a Fast Breeder Reactor, to which we will return)"...because the fissile material is mixed with a much larger amount of non-fissile material (Uranium 238) and also because (the) material rapidly disrupts (as it did at Chernobyl)bringing the fission process to an end...long before the reactivity reached the very high levels in an atomic bomb."

It is true that the structure and isotopic composition of the fuel in a thermal reactor differ from those of the fissile material in a weapon. That said, the same prompt neutron from U235 fission cause the chain reaction in a thermal reactor and in a U235 bomb. The difference is that the chain reaction is controlled in a thermal reactor by maintaining a balance between the supply of the neutrons available for fission and their absorption by (he U238 (and also by the water coolant in the RBMK design) or escape from the core. This balance is mainly achieved by a combination of increasing the efficiency of U235 fission through slowing down the prompt neutrons via the moderator (graphite in the RBMK), and adjusting the resulting reactivity level by inserting movable neutron absorbers— called control rods—between the fuel rods.

However, uncontrollably fast power-level changes would occur even for slight reactivity adjustment were it not for the fact that a tiny fraction (less than 1 % of the neutron supply is emitted after a delay of 1/10 seconds. This "delayed neutron fraction"—from fission products— is used by the reactor designer to allow slow enough reactivity changes for human control to be possible.

Radiation

The photo could be of a cornfield anywhere,
but for the two forlorn, elderly gentlemen
with Tolstoy beards standing in the foreground

The taller one to the right holds out
a loaf of a bread on white linen
embroidered with a crewel flower that's upside
down and hung over his unseen hands.
The man on the left is hardly taller than
what appears to be a bumper crop.

He holds a makeshift banner that could belong
to any hippie demo declaring MAKE LOVE
NOT WAR or LIVE AND LET LIVE,
but I can't
decipher the black banner's Belarussian.
The white letters look jumbled and words back
to front, reminding me of what 'live' becomes
when spelt backwards and what's hidden
behind everything these men live f
caught in a cornfield that could be

Greg Delanty

What happened at Chernobyl was that the operators managed to put Unit 4 into a condition where the delayed neutron fraction was swamped by an over-supply of prompt neutrons. This led to an uncontrollable prompt-critical excursion or power surge. All was lost when the water phase-changed to steam (a potentially fatal weakness in water-cooled reactors, as already mentioned). Neutron absorption was reduced, leading to a second prompt-critically. These effects combined to cause what amounted to a very small, inefficient, but entirely nuclear explosion, which only stopped when the core blew itself apart, ending the chain reaction.

The UK nucleocrats buttress their denial of such an eventuality with two more contentions. The report states: "In a power surge, even one in which a 'prompt critical' state is reached, the presence of the Uranium 238 would reduce the increase in reactivity by absorbing more neutrons as they slowed down— the Doppler effect. More Importantly, the majority of fission would be caused by slow neutrons."

Taking its Doppler effect point first, we quoted earlier from the Spanish analysis that th efficient effect would have been overwhelmed in Unit 4. The AEA may in fact agree because, when discussing the accident initiation elsewhere in the same report, it correctly states: "The void effect dominated the Doppler effect and made the power coefficient of the reactor positive.". The AEA thereby rejects its own first contention.

The AEA rates its second contention as more important: "...the majority of fission would be caused by slow neutrons." Here it appears to ignore the fact that "slow" (i.e. moderated) neutrons can cause prompt-criticality. The word "prompt" only indicates a lack of dependence on delayed neutrons. As we have explained, in a prompt-critical excursion any fissioning by delayed neutrons will be swamped by excess of prompt neutrons. Both contentions, therefore, are contradicted by reactor science principles.

The AEA states that such a process would be brought to an end"...long before the reactivity reached the very high levels of an atomic bomb." The Spanish analysis estimates that about 1200 gigajoules of energy were released in the eruption. One kiloton is 4200 gigajoules: so 1200 gigajoules are about 0.28 kilotons. That is more than the 0.25 kiloton yield of the W54 warhead fitted to a variety of US-battlefield nuclear weapons in the early 1960s; while the smallest fission warhead made—for a Special Atomic Demolition Mine—had a yield of 0.01 kilotons.

Of course, 0.28 kilotons is insignificant when compared to even the 13 kiloton yield of the crude and inefficient Hiroshima weapon. But what matters is that no containment could withstand it. This raise another point omitted by the AEA: it is well-known that reactors are much greater sources of contamination than weapons. The Hiroshima bomb contained about 15 kg of U235; while about 5 kg of Pu 239 were used in the Nagasaki device. The core of Unit 4 is estimated to have contained about 1500 kg of U235 and 500 kg of Pu 239 before it erupted, apart from a huge inventory of other very dangerous fission products like Iodine and Caesium. Hence the Chernobyl eruption was a tiny fizzle of a nuclear explosion in a device containing the potential fallout from roughly 100 Hiroshima and 100 Nagasaki.

In sum, the nuclear power establishment admits that an uncontrollable prompt-critical excursion occurred which ended only after dispersal of the fissile material, but tries to divert attention from the fact that this describes a nuclear explosion. It took the Spanish analysis to provide crucial facts (clearly available to the AEA) about the nature of the eruption to establish that Chernobyl was indeed the world's first nuclear explosion in a power reactor.

What was it like on April 26?

We have taken the following from "Inside the Beast" by Sergei Kiselyov from the May/June 1996 issue of Bulletin of Atomic Scientists. For the sake of brevity the article has been edited but we would urge our readers to read the original as well as the other articles in this issue of the Bulletin which is their Chernobyl special.

It is still so much easier to immortalise the names, of those who perished than to provide for the living. There are liquidation workers, inhabitants of the Chernobyl zone, and children who in the past 10 years have been exposed to monstrous levels of radiation. Unfortunately, the government remembers them only on anniversaries.

Most of the men I interviewed have remained silent for 10 years-not because they were scared to talk about what happened at the Chernobyl power station at 1:24 a.m. on April 26, 1986, but they have been more concerned with how to survive and how to provide for their families in these complicated times.

I interviewed many of them in their apartments. I was struck by the fact that their homes were all decorated "Chernobyl style," that is, in a somewhat provincial fashion. More striking still was the fact those who suffered the most from the explosion at the nuclear power station were convinced that it should not be shut down.

Yuri Korneev

Yuri Korneev was assigned to work at Chernobyl immediately after graduating from technical school in 1976. A turbine operator at Unit 4, he was on duty the night of the experiment that caused the accident. Today, Korneev is 39, married, and has two sons. He believes he was exposed to 710 roentgens.

The responsibilities of a turbine operator include making sure the turbine and auxiliary mechanism are functioning properly.

On April 26, precisely at midnight, I started my shift. I knew that an experiment was planned for this night at Unit 4. The seventh turbine was already taken off line, and the eighth turbine, which I operated, was next in line for shutdown and routine maintenance work. The internal energy experiment was supposed to be conducted on this turbine. Many turbine engineers, the chief engineer, and the shop superintendent stayed for the night shift to supervise the experiment.

An hour after I started my shift, the Unit 4 dispatcher informed me that the experiment was starting. I went to control panel, as I had to perform all the steps necessary for the shutdown of the turbine.

Usually, I went through a procedure without any problems. But this time something went wrong. At the moment the turbine stopped working, there was a sudden explosion in the area of the tubing corridor. I saw pieces of the reinforced concrete wall begin to crumble, and the reinforced concrete roof of our Turbine 7 began to fall.

In a few seconds the diesel apparatus kicked in, and emergency lights went on. I immediately looked at the roof of the turbine room. It was crumbing in layers. Falling pieces of concrete were slowly coming closer to my turbine.

It was all unexpected. It was difficult to figure out what was happening. The explosion and crumbling of the roof took only a minute, maybe even less. Right after mat, a shift supervisor, Boris Rogozhin, and the [now] deceased deputy chief engineer ran into the turbine room from the control centre. I was ordered to take care of Turbine 8 and not pay attention to anything else.

I will not go into technical details. Let me just say that I got lucky when, as a result of the explosion, the ceiling slabs fell from the reactor on the top of the seventh turbine room, which was turned off, and not on my Turbine 8.1 was also lucky when, a few minutes after the explosion, a multi-ton lead plug that closed a reactor channel fell within a meter of where I stood.

I was completely in the dark. The senior of turbine management knew nothing. The shift supervisor knew nothing. No one knew anything, and no one knew what had just happened. In the turbine room there was equipment that was supposed to start working when the radiation level increased. However, the level of radiation was so high that this equipment failed immediately.

While I was busy with the turbine, an electrician, Baranov-who later died in the hospital in Moscow-ran in and started pumping out the hydrogen that cooled the turbine generator. His actions prevented another explosion.

After everything, was done, an eerie silence fell on the turbine room. There

In Pripyat, animals crawled, half alive, in terrible pain. Birds looked as if they had crawled out of water unable to fly or walk. Cats with dirty fur, like it had been burnt in places. There were hundreds of dead birds and most of the animals were blind. Most pets, particularly dogs were later killed by special teams of soldiers. Kindness demanded it.

was small balcony; Baranov and I went out for a smoke. Underneath us in the street we saw pieces of Unit 4 and chunks of graphite thrown there by the explosion. Only later we realize what the radiation level was like on the balcony and how many extra roentgens we were exposed to during our smoke.

About two hours after the explosion I started to feel really sick. I had an acute burning sensation in my eyes, and they began to water. I was taken to the emergency room, along with Yuri Vershintn, the inspector on duty, who later died in the Moscow hospital.

On April 27, a bus whose seats and walls were covered with plastic took us to airport. A special flight brought us to Moscow, and the same type of bus picked us up at the Moscow airport.

I was in the hospital until July 14. I didn't have to have a bone marrow transplant, although there were willing donors. I was lucky; my body took care Nikolai Gorbachehko, a radiation monitor at the Chernobyl station, was at

Nikolai Gorbachenko

work at the time of accident. He had worked at Chernobyl since 1976. Now 42, he is married and has two children and a three-year-old grandson. He believes he was exposed to 300 roentgens.

Radiation monitors at the atomic power stations are like scouts during wars; they come in first and leave last. The radiation monitor measures radiation levels in the workplace before the workers come in. After the shift is over, he measures radiation levels again.

My shift began at midnight on April 26. I had to take measurements in the reactor rooms of Unit 3 and 4, and check the data units. I checked Unit 3; but on my way to Unit 41 remembered it was in the process of being shut down, so I decided there was nothing for me to do there. I was really lucky that O wasn't at the reactor when it exploded.

I returned to my duty room to have some tea. Then we heard a flat and

of itself. My diagnosis was radiation illness of the third degree. The highest level of radiation illness is the fourth.

Our locksmith on duty that night, Andrej Tarmazin, is the only man alive diagnosed with the fourth degree of radiation illness. His exposure was 860 roentgens; mine was only 710.

Incidentally, I didn't know this number after the accident; it was concealed from us. I only found out three or four years ago. The Chernobyl fireman who died in Moscow and were buried at the Mitinsk cemetery were exposed to over 2,000 roentgens.

I don't know how and why I survived. The doctors don't know either. In their reports they write that I do not have health complaints. They are right; I don't have any. The only thing is, I have two artificial lenses in my eyes, and my wife, on the other hand, is not feeling that. well. My younger son has stomach problems, the older one, heart trouble.

I haven't worked anywhere after Chernobyl.

Those who were at the station on the night of the accident get a lot of help from the current management of the Chernobyl power station. They have given us the extra money the government cheated us out of for the past 10 years. My pension today is about $250 a month. It's better than it was before.

Who is to blame for the accident? The operators were blamed for everything, and they still haven't been exonerated. But blame can be assigned [elsewhere}. The blame falls on those who built the station quickly, and those who claimed to have finished each unit before the deadline, communist-style. Blame probably also fall on those who organised the experiment on April 26, 1986. We received no instruction on that day, so cocksure were they that the atomic power station was safe and secure as an electric kettle. Nobody even thought it could explode. The people who were on duty that night, what did they do wrong?

During my visit to Pripyat I saw soldiers and officers picking up graphite with their hands. They had buckets and were collecting it by hand. They poured it into containers. There was graphite lying around everywhere, even behind the fence next to our car. I opened the door and pushed the radiometer almost onto a graphite block. Two thousand roentgens an hour. I closed the door. There was smell of ozone, of burning, of dust and of something else. Perhaps this was what burnt human flesh smelt like. Having filled their buckets, the soldiers seemed to walk very slowly to the metal containers where they poured out the contents. You poor dears, I thought, what an awful harvest you are gathering The faces of soldiers and officers were dark brown: nuclear tan. The weather forecasters promised heavy rain, and to prevent the activity being washed into the soil by the rain, people were being sent instead of robots, because there were no robots.

Grigory Medvedev

April / May/ June /July 1996

powerful thud. My colleague and decided the turbine operators had produced a hydraulic hit, which sometimes happens during the shutdown of a turbine. At that moment we heard another flat thud. The lights went out; the light on the control panel of Unit 4 went out as well. Just as in a horror film, the blast blew out the double doors that had been latched. Black-red dust started coming out of the Ventilation vent. In a few seconds, the emergency lights went on. We put on our gas masks and tried to make a call, but the phone wasn't working.

We had dosimeters that measured up to 3.6 roentgens per hour. They immediately went off scale. My boss sent me to Unit 4 to find out what the radiation situation was like there. I went to the turbine room and walked around. It was pitch black, but I had a powerful flashlight. There were pieces of concrete everywhere. With my low-power dosimeter, I wasn't able to measure the radiation level. I returned to my post and told my supervisors what I'd seen.

Then two guys walked in. They said: "Hey. buddies, help us find a comrade of ours, Vladimir Shoshunok. He's been gone for 30 minutes and we haven't heard from him. He's supposed to be on the upper landing across from the turbine room."

So I went the two men to look for their comrade. In the darkness we made our way through piles of rubble, and went up to the landing. Everything was in shamble, steam was coming out in bursts, and we were up to our ankles in water. We made our way to the structure where the man we were looking for was supposed to be. We went inside and saw there was nothing-concrete slabs of the outside wall had been thrown to the street by the force of the explosion. It was night-darkness and dust everywhere. It was impossible to see anything. Even when you shone a light, the ray just vanished somewhere. We began to call to Valodya.

Suddenly we saw him lying unconscious on his side, with bloody foam coming out of his mouth making bubbling sounds. We picked him up by the armpits and carried him down. At the spot on my back where his right hand rested I received a radiation burn. He died at 6:00 a.m. in the Chernobyl hospital, never having regained consciousness. The two guys who looked for him with me later died in a Moscow hospital."

When I returned to my post, I put on dry clothes and changed shoes. As a radiation monitor, I understood what was happening and the fate that awaited everyone who was at the station that night. Then we received an order to look for; Valery Khodymchuk. Our search was unsuccessful. As we later learned, he died in the explosion.

At 5:00 a.m, I started to feel terribly weak and nauseous. I was taken to the hospital. A friend of mine, who worked in the emergency room, saw me in the waiting room. He took me aside, gave me 500 grams of pure alcohol, and told me to drink that.! drank it and washed it down with water. Then I called my wife and told her I was OK. Later on, the doctors told me that the alcohol, which I drank on an empty stomach, helped me a lot.

On April 26 there were already doctors from Moscow in the hospital. Seven or eight of the most difficult cases were flown to a Moscow hospital on the same day. They all died in that hospital. The rest went to Moscow on the following day. I was in the hospital for six months, from April 27 to October 27. It wasn't a pleasant sensation. You go to sleep at night not knowing whether you will wake up in the morning. Many died-often those who seemed to be getting better.

When I returned to Kiev in the fall of 1986, I received the lowest possible disability rating. I was given an apartment here, although I was also offered one in Moscow. I regret I didn't stay there. The Chernobyl workers who moved to Moscow receive a much better pension than we do in Ukraine.

I worked until 1991. Then it became too difficult and I retired. Although my disability rating was increased, my pension is small. My wife also doesn't work; she is sick. My children aren't doing well cither. Their blood tests are bad and they have constant headache. 1 check into the hospital twice a year for a battery of tests.

Yuri Andreev

In April 1986, Yuri Andreev was a senior engineer at Unit 2 at Chernobyl. He had worked at the Krasnoyarsk and Smolensk power station before moving to Pripyat in 1982. Since 1991, he has served as president of the Chernobyl Union of Ukraine, an advocacy organization for the thousands of Ukrainians who participated in the clean-up after the accident. Andreev is married, with two daughters. He believes he was exposed to 150 roentgens.

At the midnight on April 25, 1986, my shift ended. I left before Unit 4 exploded. I spent the night of the 25th-26 at home, and didn't hear the explosion. At 9:00 in the morning, my wife returned from the market and said there were rumours in town that there had been an explosion at the station. I told her I didn't believe it, and I took my daughter out far a walk. I saw the streets of our town Pripyat-with 55,000 inhabitants-bein

washed with a sudsy solution. There were also many police on the streets, and they were armed with automatic weapons. Although there were no signs

of panic, everywhere beer and *Kvas* [a fermented low-alcohol drink] where being sold from the tap.

After I saw all of this, I decided to walk to edge of town, where I could see the power station, which is located two kilometers outside of Pripyat. I saw that there was only a wall left of the central building of the station, the one around the reactor. There was no roof, grey smoke was rising above the ruins. I understood immediately that reactor fuel was exposed to the atmosphere.

On the way home I noticed that there were a number of armoured vehicles from army chemical intelligence, and soldiers with dosimeters. I asked one of the officers what the radiation level was. In response, he hastily blocked the scale from view and told me to mind own business. One emergency vehicle after another headed from the power station to the city hospital.

On my return home, I didn't want to frighten my family, but I told them not to go out for any reason, and to wrap the shoes they had walked in today in wet rags and put them outside, and to conduct a through wet cleaning of the apartment.

My shift at the power station began at 4:00 p.m. [On the way to the station], the bus took a different route; it went on a detour past the cooling pond and the ruins of Unit 4.

I realized that what I had seen from town was nothing. I couldn't have imagined that something like this would ever happen. I saw parts of the reactor a person should see only once in his life-before the reactor goes on line. On the ground were pieces of the roof, thrown there by the force of the explosion, as well as drums from the separators, pieces of tanks from the emergency cooling system, and many other parts. It was obvious that the reactor was exposed to the atmosphere and "breathing." Toward evening you could see an even, dark purple glow above the active zone.

Our shift began with an order to shut down Unit 2. Everything started well, but then there was a glitch. During shutdown, the fourth turbine suddenly went off. Lights went out on the reactor's control panel. The alarm sounded. In a second the emergency light kicked in. But in this fraction of a second, I felt fully my helplessness before the nuclear machine. I felt with sudden intensity what my colleagues had gone through the night before, when they couldn't control Unit 4.

However, the shutdown of Unit 2 was successful, as well as the shutdown of Unit 1. [Unit 3 had been shutdown early in the day.]

The next day, April 27; the evacuation of Pripyat

Col. *Anatoli Kushnin*

Col. Anatoli Kushnin, chief of the chemical defence air force division. Kiev military district, served in the Chernobyl zone from April 26 to May 22, 1986. A member of the army since 1968, Kushnin graduated from the military Academy of Chemical Defence in Moscow in 1977. At the time of the Chernobyl accident, he was chief of the air force's chemical defence unit charge of Ukraine's Radiochemical and Biological Defence force. Now 46, he is married and has two daughters. He believes he was exposed to 130 roentgens.

Certainly Heroic, But Was It Worthwhile?

Colonel Nesterov, was the first to fly a helicopter on a 'bombing run'. He flew over the crator of the nuclear reactor. At 110 metres over the crator the radiometer registered 500 roentgen per hour. He could feel the heat from below. A mighty torrent of radioactive gas, ionized by neutrons and gamma rays, rose up. All this without respirators. The helicopter was not protected underneath with lead. They stuck their heads out through the open door to aim at the nuclear crater and threw the sacks. The first twenty seven crews soon had to be sent to Kiev for treatment. The pilots began to find it hard to breathe. Throwing sacks had a significant effect on the active zone. The amount of radioactive dust emitted rose sharply particularly on the first day. People breathed all this. For a month afterwards uranium salts and plutonium were washed from the blood of these heroes. On subsequent days the pilots themselves began to put lead sheets under their seats and to put on respirators.

residents began. My wife and children went to the Zhitomir region, where my wife's parents lived. I remained at the power station, as did all the station personnel. At first we were taken our shifts by bus, as before. Thus, during one round trip to work, we were exposed to 5 roentgens, the maximum considered safe as an annual does. Later we were taken to work in armoured vehicles. For a while after the accident, the station cafeteria was closed; all the stores in Pripyat were also closed. The town looked abandoned and frightening.

We were left to survive with an order to hold the station together. J didn't sec any outside help. We had no dosimetric devices; the once at our disposal didn't work. The most popular books for us at this time were whatever textbooks on haematology and civil defence we could find in the libraries. At least they provided some information on radiation and its doses.

I continued working at the Chernobyl power station until 1988. Then began having problems with my health. I fainted at my work station several times. Incidentally, to maintain secrecy all the medical histories from 1986 were destroyed in 1989. Station personnel received new medical histories that no longer contained the results of their 1986 blood tests or their diagnoses.

I found out about the Chernobyl accident on the morning of April 26, 1986, when I came on duty. The duty officer told me about the accident and fire at the Chernobyl power station.

First. I tried to find out what the situation was like at the station. I called the headquarters of the army's chemical defence forces for Kiev military region. The senior officer there informed me that the radiation situation was bad as a result of an accident, but that there was no precise data available.

In the meantime, the headquarters of the Kiev military region ordered an immediate transfer of pilots from Kirovogradsky region to the air field closest to Chernobyl . At 11:30 p.m. the regional air force commander, Major-Gen. Nikolai Antoshkin, and I drove to Chernobyl. We approached the power station by 2:30 a.m. A red glow was over it. We passed the station and went to the town of Pripyat. The liquidation [cleanup] headquarters were located at the city hall.

We immediately got to work. In order to put out the reactor fire, the decision was made to dump sand over it from above. It was necessary to form teams to fill sacks with sand, which we later dropped into the reactor core. Then we dropped lead into the reactor. There was a supply of boric acid at the station. We also dropped boric acid. Since the rods used in stopping a nuclear chain reaction are made of pure boron, boric acid could help to retard the reaction as well.

All this work fell on military pilots. At the time, there were 80 helicopters and air-planes of various types deployed in Chernobyl. Every officer in our on-the-ground provision group was responsible for various aspects of this job. At the head of the chemical service, I was responsible for radiation safety on the staff, for preventing military personnel from being overexpose, and for recommending appropriate safety measures. For example, I told the helicopter pilots to cover the floor of their machine with sheets of lead.

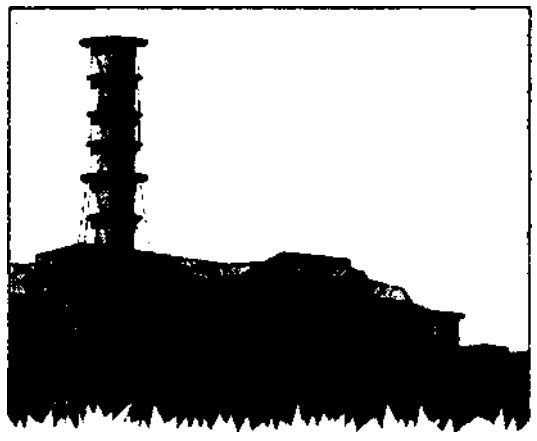
I was in Pripyat. The helicopter strip was located 11 kilometers from the reactor. I used a deserted military airstrip midway between these two points as a decontamination station for helicopters and pilots. Special technology was sent there. After flying above the reactor, helicopters were washed with special solutions and their crews showered and received new uniforms and shoes. The helicopters were returned to their base practically clean. Those machines that couldn't be cleaned remained within the 30-kilometre zone. We left helicopter engine, which couldn't be treated chemically, there as well.

Our military pilots worked zealously. I don't remember a single case when someone showed fear, a lack of discipline, or disobeyed orders. By May 4 the pilots had buried the reactor core in sand despite conditions that were difficult and dangerous. The dosimetric devices on these helicopters measured radiation levels of up to 500 roentgens an hour. In the first days after the accident those dosimeters went off scale. The crews were exposed to enormous radiation doses during their flights over the reactor. Pilots had to be substituted all the time; afterward, crews were sent to a military hospital in Moscow. Not all of them survived. Recently, military test pilot Anatomy Grishchenko died in the United States. He was the one who tried to lift a huge dome over the exploded reactor with biggest helicopter in the world, the MI-26. He didn't succeed, but he was exposed many times to huge doses of radiation. He wasn't even told about that for a while.

Everything to do with radiation levels was top secret. In early June 1986 I signed for a coded government telegram received from Moscow listing 13 pilots about the consequences of the Chernobyl accident. It included radiation levels, among other things. This coded telegram was signed by General Secretary Mikhail Gorbachev.

I was also exposed to a significant dose. I was hospitalised with symptoms of radiation illness. My situation would have been worse had I not taken certain precautions while in Chernobyl. I believe that cloth masks only protect respiratory organs from large radioactive particles of dust, not from radioactive isotopes, which permeate the air.

I saved my self with cigarette smoke, as strange as that may sound. Along with the inhaled smoke, isotopes of radioactive iodine entered the lungs; then they got absorbed in the smoke particles and were exhaled along with them. In short, I always had a cigarette in my mouth, believing that nicotine would be



less dangerous than radioactive isotopes. My first blood tests confirmed that they didn't get into my body in the first days of work at Chernobyl. Doctors couldn't believe that my tests revealed no abnormalities.

Nevertheless, I can't call myself a healthy man today. My leg hurts, and I limp when I walk. Often I have headaches. I head the Chernobyl Union at the central office of the Ukrainian Ministry of Defence, which consists of military men who worked in the aftermath of Chernobyl. Among other things, our organisation procured the right for the officers who were at Chernobyl to retire five years before the legal retirement age, with a full retirement package.

I spend April 26 in a traditional fashion: I take a bottle of vodka and drink for those who perished at Chernobyl. However, I believe at this point the Chernobyl station should not be shut down. Its safety level right now is practically 100 percent. If so much has been invested in its safety, why take it off line?

April / May/ June /July 1996

Valery Starodumov

Valery Starodumov, a senior engineer working in radiation safety, arrived at Chernobyl on June 6, 1986. His group of cleanup workers of "liquidators" were known as the "rooftop cats," because they cleared the roof-and other areas-of the most dangerous materials before other workers came in. Today, Starodumov serves as chief of Ukrainian Department of Radioactive Waste Management and deputy director of the Ukrainian Government Committee on Nuclear Energy Uses. Now 52, he is married and has two children and a granddaughter. He believes he was exposed to 300 roentgens.

Utter Confusion

It is hardly surprising that in a situation of complete blackout of information, a number of people responded to the rumours by rushing to leave via the road that led through the Red Forest'. Witnesses reported that along this road which was already 'shining' in the full force of radiation, women wheeled prams. There was no plan of evacuation and we did not know which blocks of Pripyat flats or which micro-regions had been placed in which villages. I still can't understand what scheme was used, who was sent where. I would phone a village council and ask "Do you have such and such parentSi their children are looking for them". And the reply "We have such and such children without parents." One would sit all day and phone all the village councils in turn.

The day of my arrival at Chernobyl was my first day of work. When I arrived in the early evening of June 6, I found that there was no one to translate the operating manual for the two German robots, the F-l and F-2, that we needed to work on the remnants of the roof of Unit 4. It took me all night to translate the manual.

Until June 19, I worked on finding a place for a special laundry for washing and treating the clothes of the liquidators. I also tried to analyse the use of various protective substances and working clothes.

Then I was assigned to group of jokingly dubbed the "rooftop cats" by the other .liquidation workers. This group consisted of 32 nuclear experts, drawn primarily from military ranks; it was given assignments in the most dangerous and responsible areas. The head of the group, Yuri Samoilenko, later received the Hero of Socialist Labour medal.

The group's of primary responsibilities were verifying the structural integrity of buildings at the power station, evaluating radiation doses, identifying radioactive hot spots in certain areas around the power station, evaluating the possibility of removing fuel from the reactor taken off line, and other such tasks.

Later we evaluated the feasibility of doing certain kinds of work on the roof of Unit 4. On August 30, 1986, we removed the most radioactive objects on the roof with our own hands. We made it possible for the deactivation workers to enter the breach that we cleared. On this day each member of our group received a "hit" of radiation of 30-35 roentgens. But we were able to lower the overall radiation field at the entrance to this area from 1600 roentgens an hour to 800 roentgens. We did it by tossing the remnants of fuel assembly units thrown there by the explosion back into the reactor.

Army chemical defence units followed us on the roof and into other areas of the destroyed reactor. Many of them were exposed to high levels of radiation; I doubt that all of them are alive today.

All the mistakes that led to high radiation exposure of liquidation workers had to do with the fact that the people doing the work weren't professionals. If we had prepared those who worked on the reactor roof more thoroughly, if we had given them a year-better yet, three year-of preparation;if for this period we had conserved the station under dust-suppressing elements to avoid the release of radioactive elements into the atmosphere; we would have avoided the high number, of causalities and saved our genetic heritage.

In 1987 I was in the hospital from July to October. My hair fell but; three hot particles were found in my oesophagus and intestine. Since then I have not had particular health problems. The pension I received as a liquidator at the Chernobyl power station is laughable. It amounts to a little over $20 a month.

As far as the urgent need to shut down the Chernobyl power station, I think it's a made up problem, more political in nature than economic. The world says the station is dangerous because it is located so close to Ukraine's European borders. However, if you compare the location of other power stations-Smolensk, Kursk, and Ignalia-that have the same kind of reactors as Chernobyl, they will be found to be even more dangerous to the West. I think the main issue here is the fight for a piece of the energy market. Recently a map from Germany and Austria came to my attention. You can clearly see lines going system. The high-voltage line from Chernobyl stops in Austria-Chernobyl still exports energy and someone is interested in getting rid of competition in this market.

Source: Sergei Kiselyov. Bulletin of Atomic Scientists May / June 1996

Heroes *Then*, Zeroes *Now*

It took the Soviet authorities some time to realise the true extent of the disaster on their hands. When they did, there were frantic appeals from ministers for volunteers to fight the invisible enemy 'radiation'. Many did volunteer and there were many others who were conscripted against their will. What is life like for some of them and their families, ten years later.

Vika Troschuk

My husband was woken by an alarm on the night of 26 April 1986. He came home the next evening. He was one of the drivers for the military motorcade which responded to the accident. Both trucks and drivers had to wait for some time in the "auburn forest" but their dosimeters were broken so no one knew what radiation doses they had received.

In 1987 he suddenly lost his consciousness while driving and caused an accident. After that his health deteriorated and he spent a long time queuing at hospitals where no examination or medical treatment was available. In 1990, his health abruptly worsened. He spent six months in hospital having tests. He was diagnosed as suffering from nervous system deterioration caused by radiation and was registered as a second level disabled person.

In autumn of 1994, he got worse. An examination in the Kiev based radiological centre found that his liver was inflamed. But there were no medicines to treat him and he was sent home. He went to the district clinics complaining of pains in his spine and was transferred to a Crimean sanatorium. In March 1995, he was diagnosed as having cancer of the liver and he died in May.

I am 49 and unemployed. At my age it is difficult-almost impossible to find a job. Chernobyl public organisations paid for his funeral. That is all. The state that killed my husband does not see the need to support the family. So survive if you can.

Now Chernobyl has begun to cast its shadow over the life of my son, Ihor. In 1988—1989 he was on military service in Kovpyty, an area contaminated due to Chernobyl. Now, like my husband he is seriously ill. He is fading before my eyes and he does not even have the status of a Chernobyl victim. How can I, poor and stripped of everything help my son? Chernobyl took everything I had. We are now living like a piece of useless garbage on a human rubbish dump.

Chernobyl took everything I had. We are now living like a ple€e of useless garbage on a human rubbish dump.

Vasiliy Osipovich Kotetsky

I began to have health problems in the first few years, but I attributed them to the first hard months of adapting to a new environment, to family problem, to problems of employment and residence, and other causes. But over the past three years it has become worse although I don not smoke or drink excessive alcohol. Both my wife and myself are now certified as level 3 disabled persons. My children (my son aged 16 and daughter nine,) also have health problems associated with the consequences of Chernobyl. We are a typical family of Pripyat liquidators.

There is no rehabilitation and treatment centre for the Chernobyl victims in western Ukraine. District doctors send us to different hospitals or to narrowly specialised medical departments. But our complicated medical problems need complex medical treatment. I do not remember a single day in the past two years that I have felt well. What can I do when my medical card repeated confirms: second grade encephalopathy, dolichostigma, gastritis, cholecystitis, chronic prostatis, haemorrhoids, functional troubles of the left heart ventricle and other "minor" conditions? What can I do when my wife and I have to often massage the legs of our daughter while she groans in pain trying not to wake her brother or the neighbours?

They receive us at medical facilities but often do not register our visits. Several times a year we are sent to the therapy department, the neurological department, to urology, or to surgery. But it is all a mere formality and does not really help.

It is difficult to get a sanatorium voucher. We have to visit a lot of officials and the state regulations on voucher distribution and compensation are amended every year. It takes a lot of time, effort and energy which is not worthwhile in terms of the medical treatment we receive or the improvement in our health. And it all costs so much. Where on earth are these free drugs? The system for distributing compensation and payments to Chernobyl victims is bureaucratic and an affront to human dignity. It is humiliating to show my certificates to everyone, to produce multiple copies of documents, to bow to every mandarin.

We want to see our children make their own lives. We want to give them a little happiness. That is the main purpose of our lives now.

Eugenia Dudrova

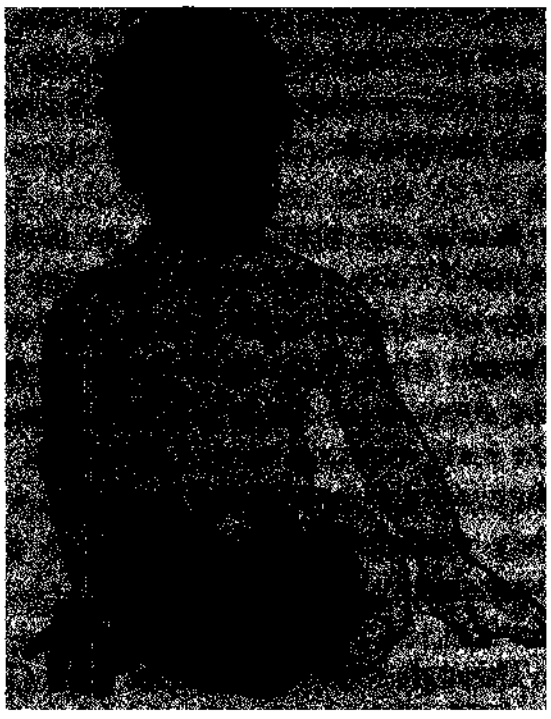
I was friends with Olga from our early childhood, as far back as I can remember. We were more than sisters-we were inseparable. We entered school together, studied in the same music classes, spent all our spare time together.

In the spring Olga felt worse and doctors found that she had sarcoma-a deadly tumour. Almost immediately they carried out surgery and she felt better for several days. But then the unbearable pain began again. Olga was very upset that she could not play piano for long. We had a dream to study in the conservatory after finishing school. You cannot imagine how determined she was to overcome her disease but she was soon in hospital again.

Olga's legs became paralysed and shortly after that her arms too. My mother told me that my friend would die soon. I could not believe it. I dreamt that one sunny day a miracle would happen and we would run home hand in hand away from that awful hospital.

But there was no miracle. She prayed for help but we could not help her. Doctors refused to give her morphine saying they were short of the drug and could not use it all for one dying person. One of the doctors told us to take the child to die quietly at home.

1 do not know how to live without her now. I know that I could never find another such friend. I have lost half my life, half of myself. Why did adults create such a disaster? We did nothing wrong. I and my friend were only three years old when the. reactor exploded. I wonder if I face the same fate?



Source: Testimonies:
Chernobyl Papers 1 Greenpeace

Containing the Uncontainable

A disaster is not just the initiating incident. It is also the response of the system to the original incident. Proper mitigation efforts can do much to reduce the effects of even serious accidents. As the following article shows, at Chernobyl many of the steps undertaken towards mitigation were of no help at all. Lack of previous planning and an overwhelming desire to hide the facts from the people were the prominent causes for the often unnecessary excessive radiation exposure.

Suppressing Truth Was A Greater Priority Than Helping The Victims

The Chernobyl accident exposed glaring weaknesses in the Soviet system: its backward technology, its sloppy safety standards, its inability to admit failure. It brought to the surface many of the injustices, inefficiencies, and secrets that the government "had tried to keep hidden.

Old habits die hard. Ten years after the accident, many bureaucrats in the former Soviet Union, particularly in Russia, are still too secretive and too much given to obfuscation.

Heroic, but ineffective

By the time of the Chernobyl accident, Soviet citizens had become masters at avoiding accountability for mistakes and failures. Perhaps no other statement quite capture the essence of this lack of responsibility as one allegedly made by a NIKIET specialist, whose organisation (the Moscow-based Scientific Research Institute of Power Engineering) designed the RBMK reactor series. When asked to aid in clean-up and mitigation efforts, he was widely quoted as saying: "This is no longer a nuclear reactor. Our expertise is in nuclear reactor...so let others clean it up."

And so began an accident containment and mitigation effort portrayed by Moscow as one of the most difficult and heroic engineering tasks ever undertaken. In reality, the period to the end of November 1986, during which the sarcophagus was constructed, was marred by an inept and reckless attempt to conceal the extent of the accident-despite the fact that unwitting "volunteers" (including former Soviet dissidents and political prisoners) risked their lives in several ineffective accident-management actions.

The Governmental Chernobyl Commission (headed by Deputy Chairman of the Soviet Council of Ministers Boris Scherbina) was formed during the morning of April 26, 1986, and in a manner that resembled a cry to arms,

rallied major Soviet organisations and people to mitigate the consequences of the accident. It was clear from the start that no concrete emergency plans had been previously formulated-no one was prepared to respond to an accident of this magnitude.

Il was not until midday on Sunday April 27 that anyone in Moscow had any official idea what had happened. People from the station had surveyed the remains of the reactor building in the early morning hours of the 26th, but they were either afraid to report what they thought had happened, or they were simply not believed.

Through most of the first day, Gennady Shasharin, a key Soviet energy official, thought the core was being effectively cooled by water. Based on this and other incomplete information, the central authorities in Moscow did not immediately sense the urgency of the situation and delayed, for example, the evacuation of residents from what later became the 30-kilo-mcter Exclusion Zone. They didn't want to create panic.

Significantly more radioactivity was released into the atmosphere than Soviet authorities were willing to admit at the first major Chernobyl conference, the IAEA's Experts Meeting in Vienna, in August 1986.

This does not imply that during the active phase of the accident Soviet officials knew that the helicopter campaign had not covered the core. They almost surely believed that the helicopter crews had been successful. But the time of the August meeting, the officials had had ample time to examine the remains of Unit 4 and to conclude, as is obvious from photos, that the core had not been covered.

The scientific finding that the core had not been smothered after all undermines one of the central tenets of the official Soviet version of the Chernobyl clean-up campaign: the cult of the brave Chernobyl helicopter crews who took actions meant to put out the fire, and whose youthful deaths are honoured by a special museum in Kiev.

The Verdict of the

Disastrous consequences of the Chernobyl accident:

- A huge territory (up to 160 thousands square kilometers inhabited by over 9 million people) was contaminated with long-living radionuclides
- Big part of arable land was excluded from economical activities
- Millions of people received significant doses (the collective dose of Soviet soldires that took part in liquidation of the Chernobyl accident in 1986—1988 was higher than 2.64 millions manrem)
- 190,000 residents of the affected areas had to be relocated to clean areas
- There was a sharp increase in somatic and oncological (children's thyroid cancer) diseases; also there were phyetiological stresses that have significant influence on social-physichological state of population.

It is now recognised by specialists that protection measures as well the measures undertaken for localising the accident were not sufficient. Sometimes they were not effective at all.

The low efficiency of the protection measures was mainly due to the concealment of information about the scale of the accident. Absence of legislation regarding radiation protection of the population was another reason. The system of informing about the emergency situation at the NPP was not actualized and no recommandations on the necessary measures of radiation protection were given to public.

The regime of radiation control was put in force only 20 hours after the accident. The headquarters of civil defense of adjacent regions of Belarus and Russia were informed about the accident too late. Another complication arose from the fact that the Chernobyl NPP administration could not understand the dire necessity of timely radiation monitoring. This monitoring was carried out only 12 hours after the reactor had exploded. Some places in the plant had radiation levels up to 200 Rems per hour but because of inadequate monitoring these places were needlessly frequented resulting in a lot of unnecessary doses.

It was only two hours after the accident that, iodine prophylaxis of the plant shift personnel began. The iodine prophylaxis of the Pripyat resident began 10-12 hours after the explosion.

The absence of necessary coordination between the Ministries of Health of the USSR and of Ukraine caused ten days of delay in taking the decision about iodine prophylaxis for residents living in the 60-kilometers zone. As a result of such delays a lot of children received thyroid dozes higher than 500 rad.

In spite of significant material expenditure and participation of a great number of soldires the efficiency of decontamination was low. The positive results of such actions were achieved only on the nuclear power plants sites. In other areas the decontamination had no desired results and only caused the additional irradiation of liquidators. From 1990 the scale of decontamination had. decreased to minimum.

Clearly, these "liquidators" were brave and selfless. They were also, unfortunately, used by Soviet authorities to create an impression in the coming months and years that something had been successfully done to contain the accident.

In August 1986, when Academician Valery Legasov, head of the Soviet delegation to Vienna, was faced with the fact that release of radioactivity began to increase on April 30th and May 1st, and that mitigation efforts apparently had been unsuccessful in stemming these release, he reportedly exclaimed: *"The people would not understand. We have to be seen doing something !"* Later that year, Legasov told the Soviet Academy of Sciences: " I *did not lie at Vienna, but I did not tell the whole truth."* Legasov committed suicide by hanging himself at home on April 26, 1988, two years to the day after the accident.

"The people would not understand. We have to be Been doing something.!"

There seemed to be an overriding desire by the government to convince the people of the Soviet Union and of the world that things were under control, and that the heavily damaged reactor building was isolated and secure. As it was being constructed-and to this day the most visible and attention-drawing symbol of triumph over the accident, the sarcophagus, was consistently portrayed as a tremendous concrete-and-steel engineering achievement that tightly retained radioactive debris. Further, the government claimed there was a complete accounting of the initial inventory of fuel and fission products.

In May 1991, Richard Wilson, professor of physics at Harvard, spoke that first International Sakharov Conference on Peace, Progress, and Human Rights in Moscow. Based largely on extensive private conversations he had with Russian scientists, he summarised several ways in which the Soviet government had attempted to control or censor information about the consequences of the accident:

- On Legasov's instructions, about six pages concerning radioactive releases in Belarus were removed from official report just prior to the August 1986 IAEA meeting and were not discussed.

- Several pages detailing the large quantilies of radionuclidesdeposited 100 kilometers and more Northeast of Chernobyl in the Bryansk oblast of Russia were removed from the report following directives from the Soviet Central Committee.

- Dosimeters in the possession of physicians and private individuals who had worked in the mitigation efforts following the accident were locked up by the KGB.

- Publication of "unauthorised" measurements of radioactivity were forbidden-even as late as 1990.

- Physicians in Ukraine and Belarus were forbidden to mention radiation in their medical diagnoses.

- Appeals by private individuals in Belarus that children not be allowed to drink milk in the first weeks of May 1986 were stopped for fear such warnings might cause panic.

- Health records of the "liquidators" (soldiers and others who constructed the sarcophagus and did clean-up work in the zone) disappeared after their work was completed. (Since the collapse of the Soviet Union, these data have slowly begun to surface.).

The range of the Soviet deception regarding Chernobyl seems endless. Consider the sarcophagus, which one Soviet document called a "concrete cube." The amount of concrete *claimed* to have been used to construct the sarcophagus range from 300,000 to 410,000 cubic meters. However, if one simply takes the cube root of this range of values,, the dimension of a pure block of concrete with these volumes would be in. the range of 67 to 74 meters on a side, This is larger (and certainly taller)than the actual sarcophagus, which is mostly empty space.

According to the structural drawings of the sarcophagus, the amount of concrete actually used in constructing the sarcophagus was about 161,000 cubic meters, which is still a lot of concrete. But a great deal of it leaked through holes in the reactor building onto the grounds of the station, or was used to cover the ground to shield workers.

The net affect of the government's propagandists claims was to draw attention away from the affected people and the extensive contamination of the environment, including great tract of agricultural land, and focus it on the sarcophagus, which represented "victory" over the accident. The Soviet leaders themselves wanted more than anyone else to believe that most of the contamination was contained within the sarcophagus, and so the stage was set for the creation of a myth that would remain unquestioned for several years.

"They should have given a little thought to the problem before acting so haphazardly," is the restrained assessment outside experts often make of the Governmental Commission's methods. Rather than carefully thinking through mitigation efforts, the Governmental Commission's intention were dictated by the passion to remain in control. For example, one must question the wisdom of constructing an 8.4 Kilometre perimeter wall, which was sunk into the ground to a depth of 30 meters. The project, known as *Casa Grande* , was abandoned when only partially complete. It was supposed to surround the station and stop the spread of radionuclides to nearby bodies of water.

The project was abandoned because by the time the workers were ready to extend the wall through the "Red Forest" (so named because the trees turned reddish before dying), the army had not got around to decontaminating the area. One bureaucratic tie-up led to another and the project was eventually "forgotten."

Meanwhile, the partially constructed section of the underground wall between the station and the Pripyat River acts as a dam. The result: the level of the ground water had risen to within 4.5 meters of the surface by 1992, according to Aleksandr Borovoi, head of the Department of Radiation Research at the Kurchatov Research Institute in Moscow. That is, the ground water level, which seems to have reached equilibrium, is much closer to the contaminated now than in 1986.

Another line of defence that was as ineffective as *Casa Grande* was the valiant attempt by miners and engineers to construct a heat exchanger below the core by tunnelling beneath the foundation of Unit 4. The reasoning: In the event of a much-feared "China Syndrome," there would be one more barrier between the ground water and the molten core. The project was undertaken Well after the active phase of the accident, and when it became clear there was no danger of a melt-through, it was abandoned. Workers in the area now call it the "Moonshine Still," because of its complex array of cooling pipes.

How much fuel?

No one actually knew how much nuclear fuel was left inside Unit 4 after the accident, nor did anyone know its condition well enough to predict its future behaviour. Preliminary analyses of hot particles in Sweden and Germany indicated that approximately 3 to 6 percent of the *mass* of the core, or about 6.7 metric tones, had been released beyond the bounds of the station. Based on these early results, the Governmental Commission hastily decided that 96.5 percent of the initial 190.2 ton fuel load was still located within the core region. This official estimate became the ultimate arbiter, the criterion to support the notion that the fuel had been accounted for and was tightly held within the sarcophagus. It was the key bit of the data with which to convince the World that everything was under control.

The Soviet leaders themselves, it seems, wanted to believe this, even if based on questionable evidence. For example, one of my colleagues recalls an incident at the Kurchatov Institute in which measurements by the *Igla* System (a wand like probe suspended from a helicopter) were presented and interpreted. In analysing the *Igla* date, it was concluded that the largest amount of fuel was contained within the reactor core area. Following this, an internal document was prepared detailing the locations and quantities of fuel within the reactor building.

The document seems to have been used to provide information to the IAEA's Experts Meeting in August 1986. Unfortunately, not only there-was almost no fuel in the reactor core area (the core shaft is virtually empty), but a few years later, when researchers entered the area of the Central Hall to examine more closely the remains of the reactor, the *Igla* detector wand was found to be jutting partially out of the southern spent-fuel pool, approximately 12 meters from the reactor shaft, and it remains there to this day.

How much radioactivity was released into the environment? That is still a contentious question. In 1986, the Soviet estimated 50 million curies. In my study, I concluded that the release of volatile radionuclides at Chernobyl was actually two to three times the Soviet figures. That was in line with earlier Western suspicions regarding the releases, and the estimates arc compatible with early satellite imaging investigations.

In fact, a recent publication by the organisation for European Cooperation and Development presents the findings of Swedish investigator Lennart Devell, which suggest an even greater total release of about 200 million curies, if one adds the contribution of the volatile isotopes, iodine 133, caesium 136, and tellurium 129.

Sadly, these higher release estimates support conclusions drawn by medical experts in a recent study by the World Health Organisation, which directly links the marked increase of childhood thyroid cancers and other maladies occurring in Belarus and Ukraine to releases of radioiodine from the accident.

An invincible bureaucracy

Ten years after the accident, Chernobyl is plagued by bureaucratic inertia. It is not always clear who is in charge of what in the zone. Every organisation associated with Chernobyl or the zone attempts to aggrandise its role. Organisations with curious acronyms such as Derzh Kom Atom, MinChernobyl, MinEcoBezpeka, ISTCShelter, and NVO-Pripyat all claim at least some jurisdiction.

The station controls access to the sarcophagus, and it is not eager to permit scientists to conduct research if their findings might help tip the scale towards eventual closure of the station. It is no wonder that people in Ukraine often describe the zone and the work there as *bardak-a* Russian word that literally means "whorehouse," but colloquially implies complete confusion and disorder.

The conditions under which scientists work at Chernobyl can only be described as tragic. There is a core group of about 30 of them struggling with, an "invincible" bureaucracy that serves only to impede their work.

Today, a brief tour of the zone will show anyone that little work has been done to properly dispose of now-radioactive equipment used during construction of the sarcophagus. Located just to the west of Unit 4 is an entire field of contaminated, uncovered, and rusting machinery and supplies.

Moreover, approximately 25 kilometers Southwest of the station near the

small village of Rasokha are two " machine graveyards" shopping-centre-sized areas full of fire trucks, military vehicles, and helicopters used in 1986 during construction of the sarcophagus and decontamination of the surroundings. All of these are contaminated and standing in the open, surrounded by a double barbed-wire fence-with holes. Astonishingly, workers in the zone, including some of the scientists and technicians, frequently cannibalise this radioactive equipment for spare parts.

The dollar curtain

One of the terrible ironies of Chernobyl is that the world's worst nuclear-power accident has been so thinly investigated. Only 30 or so dedicated scientists struggle to find enough gasoline to drive to the reactor where they risk heir lives to make their measurements.

Over the past decade, the lack of contact with Western colleagues for these scientists has also taken its toll. While the iron curtain is long gone, it has been replaced by a "dollar curtain." With the economies of the newly emerged republic struggling to fulfil basic needs, financial realities limit scientific exchanges.

Alexander Sich
Bulletin of Atomic Scientists

Lessons Not Learnt

What if an accident on the Chernobyl scale were to happen in India? What would be the response of the authorities? Would the experience of earlier disasters like Bhopal or Chernobyl help other victims?

In India, the answer in short is no. The nucleocrats have been so busy in denying that accident can happen at all, that they have not bothered very much with learning what Chernobyl could have taught them.

Worse than having no plan!

The first and foremost point that strikes one about Chernobyl is the absence of previous planning. If only the authorities'had known what to do in case of an emergency, one would not have witnessed the bungling described earlier. If only the firemen would have been trained earlier on the hazards associated with radiation, they would not have picked highly radioactive graphite with bare hands, would not have dawdled over a smoke in areas of intense radiation. If only more working dosimeters were available, authorities could have had much earlier warnings of the severity of the disaster. If only iodine tablets had been distributed previously in the health centres of the region, the children would not have taken in high amounts of radioactive iodine in their thyroids and would not have suffered high incidence of thyroid problems. If only more doctors were previously trained in recognising radiation symptoms they would not have had to learn everything on the fly. If only...

Till 1987, Indian nuclear power plants did not have emergency preparedness plans at all. Like the Soviet authorities, Indians too felt that an accident was so unlikely that there was no need to prepare for one. Also the argument went that planning for a possible accident would create panic amongst the populace who had been fed stories of the impossibility of an accident in a reactor. One fallout of Chernobyl was that emergency plans were prepared and periodic drills have been held. However, the plans have been made with such a singular lack of imagination, that they are worse than having no plan at all.

Getting contaminated in order to avoid contamination

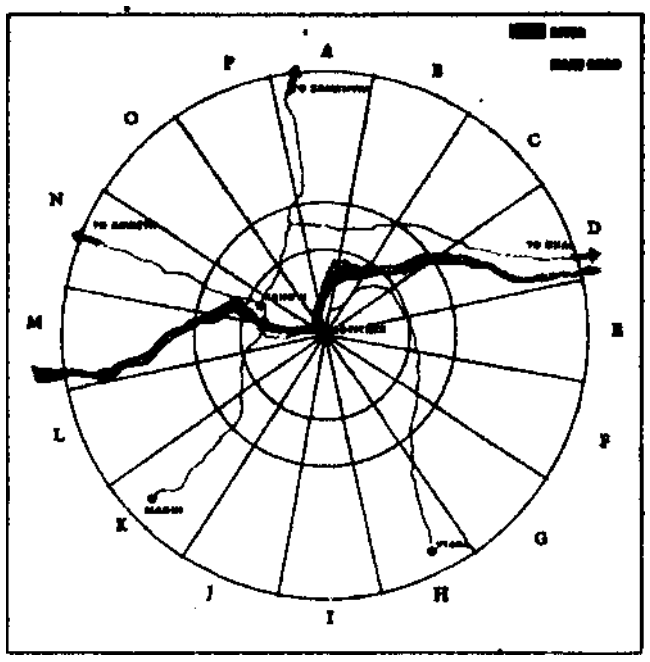
In Chernobyl all the people living in 30 km radius had to be evacuated. The accident was not just one explosion on April 26. The reactor continued to spew radioactivity on and on for well over a fortnight before things came under relative control. During this fortnight, winds did not remain confined to just one direction, they changed course. So, at different times, different regions of the country were affected. Also, depending upon the rainfall patterns, pocket's hundreds of kilometres away from Chernobyl were severely contaminated. Absence of measuring equipment and trained personnel meant that a number of such regions were not detected quickly. The authorities in fact transferred some of the evacuated population from near Chernobyl to such areas and then found that these areas were themselves as badly affected as regions near Chernobyl, and thus there had to be a second evacuation.

Let us consider the Kakrapar evacuation plan in the light of this experience. The plan confines itself to just 16 kilometres radius since doing anything more would mean evacuation of such large numbers that even our can-do everything authorities feel it to be beyond their capacities. The whole area has been divided into 16 sectors, numbered from A to P in a clockwise direction and the plan is that if the wind direction is towards sector A, then the population from there would be moved to schools in villages beyond 16 kilometres in section D (See figure). In case the wind direction is towards sector B, the plan calls for the evacuation of the population in that sector towards sector E, and so on clockwise for all sectors. This plan is totally oblivious of the geography of the area. The river Tapti

runs from East to West, and the only bridge is near Mandvi about 5 km from the plant. Thus in this plan, if you happen to live anywhere in sectors B, C, D or in sections J, K or L, then you would have to cross the river by going to Mandvi. Thus, in case the wind is in. any of these directions, people will first have to travel opposite to the wind direction to get to the bridge getting themselves contaminated in the process in order to escape the contamination in the first place. Of course India being the land of Vayu and Maruti, we can order the winds to continue flowing in one direction only while the evacuation takes place.

This is just one of the many obvious follies of the plan. It envisages keeping whole towns like Vyara (population 40,000) in a high school which can't even accommodate 5000 people packed like sardines. Or a town like Mandvi (population 15,000) and two other villages are to be accommodated in the primary school of a small town of Mangrol whose total population is less than 7,000. Such absurdities are of course, no concern to people asked to devise an emergency plan to satisfy international pressures. Things like the total absence of toilet facilities etc. are way beyond their ken during emergencies. A surefire recipe for epidemics to follow the accident.

Most of our reactors are fairly close to state boundaries. This is a general feature of reactors world-wide. Beneficiaries are generous in sharing risks with non-beneficiaries. However, the emergency plans are state civil authorities concern and thus Gujarat has no emergency plan for Tarapur whereas Maharashtra has none for Kakrapar though both the reactors are close to the state boundary.



Kakrapar Nuclear Power Plant and Surroundings

Anything connected with nuclear is a state secret

The absence of previous planning is only one of the points raised by Chernobyl. The other major point is the obsession with secrecy which denied people information about the status of the disaster and their own health for years on end. It is this feature of Soviet style which Indian officialdom has embraced with gusto. Thus although emergency preparedness plans have been prepared for whatever they are worth, they are not available to the general public even after repeated requests. The nuclear authorities will refer you to the civil authorities and the civil authorities will in a civilised manner inform you that only nuclear authorities are authorised to divulge the plan. It is another matter all together that people living near such hazardous facilities have no scruples in obtaining such information clandestinely.

Surendra Gadekar

Nucleocrots *of the World, Unite!*

The International Atomic Energy Agency (IAEA) still clings to the myth-first promulgated by the Soviets-that 5,020 metric tons of sand, clay, dolomite, boron carbide, and lead dumped from the helicopters in the first few days after the Chernobyl accident found their mark and succeeded in smothering the "burning" Unit 4 core.

But it is now clear that the helicopter pilots did not cover the core. Rather with pinpoint bombing accuracy performed under extremely hazardous conditions, these brave pilots managed to smother the infamous "red glow," which was thought to be the burning core. Unfortunately, the red glow is now widely assumed to have been only a minor portion of the core, thrown up and away from the reactor in the devastating steam explosion. The location of the red glow was 12 to 15 meters from the reactor core shaft, on the floor of the Central Hall, which was left roofless by the explosion.

About 71 percent of the fuel in the core (roughly 135 metric tons) remained uncovered in the reactor shaft after the explosion. Eventually the fuel melted through the reactor's lower lid and flowed into the lower regions of the reactor building, where it cooled and hardened into lava-like substance. About 25 percent of the core was scattered in and around the remains of the reactor building, and almost 4 percent dissipated into the environment-producing radiation contamination that was detectable over the entire northern hemisphere.

The bottom line: most of the core remained in the Unit 4 building, as the Soviet later said. But instead of being smothered, the core remained exposed to the environment, releasing radioactivity into the atmosphere for nearly 10 days, at which point the remnants cooled down on their own.

IAEA: Hand in Glove with the Soviets

Even today, the IAEA's official position, first expressed in INSAG-1 the International Nuclear Safety Advisory Group's review of the Soviet Report presented in Vienna in August 1986—support the Soviet version of events. It concludes that "accident management actions taken at Chernobyl were, generally, quite successful." Dumping the materials into the reactor shaft, the review added, "stabilised the situation at an early stage."

The IAEA's defence of this position, based preliminary on information provided by Soviet government, seems particularly awkward today, because data and analysis indicating that the core had not been smothered became available in the West at early as 1989. Even more embarrassing, is that the IAEA itself sponsored a 1990 report by Aleksander Borovoi, one of the key scientist investigating the Chernobyl accident. His data clearly indicated that the Core was not covered by the materials, and that approximately three times more caesium 137 was released into the atmosphere than the Soviet had admitted. The IAEA apparently ignored Borovoi's work.

My research at Chernobyl, which partially drew on the courageous work of Borovoi's and his Russian and Ukrainian colleagues, eventually led to a broad reappraisal of the accident and its consequences. The main intent was to recreate the sequence of events during the nine days following the explosion, when the destroyed reactor was actively releasing radionuclides into the environment.

After my findings became known in early 1994, Morris Rosen, deputy director of the IAEA, noted that he had flown over the reactor in May 1986, and he could vouch for the fact that "the material certainly got into the core region." My work, an IAEA spokesperson told a newspaper reporter in 1994, was "flawed and not worthy of serious attention."

Indeed, it is aerial observations of the destroyed reactor that were more likely to be flawed. For one thing, the 2,000-metric tons Upper Biological Shield-the reactor's "lid"-was perched, at cockeyed angle, above the reactor well, blocking the view into the reactor core.

Need to be Sceptical of Official Russian Data

During the general discussion, the chairman Dr. Shigematsu, stated that there were no cases of paediatric cancers of the thyroid in Russia. The Russian physician who presented 67 cases of thyroid cancers in children, recently operated in a centre close to Bryansk, stated the contrary. The chairman indicated he had been informed that there was no epidemic of thyroid cancer in Russia, during a medical conference on the same subject in Japan, less than two months earlier. The explanation for this misunderstanding, was the fact that, within a few months, the official attitude has changed: in Russia, facts regarding thyroid cancer may now be published.

Meanwhile, over the years, the scientists who have actually entered Unit 4, at great personal risk, have taken about 200 bore samples and have made enough visual and robotics observations to conclusively prove that virtually none of the material from the helicopters entered the core shaft. If it had, significant amounts of it would have been found in the lava like remnants of the core. In fact, only traces were found.

In retrospect, the IAEA's approach to Chernobyl should surprise no one. After all, the IAEA is in the business of promoting nuclear energy, not discouraging it. For ten years, the agency has attempted. to downplay the consequences of the accident. In 1987, for example, well before information began to filter out the Soviet Union on the true extent of the accident, an IAEA report reassuringly said, "If anything, there will be a modification downward of early calculations of risks and predictions of health consequences."

And, too, the IAEA has been markedly unaggresive in questioning official Soviet and Russian Chernobyl data and analyses because the Soviet Union (and now, Russia) plays a significant role in the governance of the IAEA.

For several years after the accident, the IAEA seemingly ignored specialists from republics other than Russia, which dominated the Soviet central government. But Russian data were controlled and often suspect: Russia had 11 Chernobyl-type reactors essential to power production, and thus it had clear political need to minimize the consequences of the accident.

Dealing almost exclusively with the Russians, however, not only restricted IAEA access to information, it alienated the IAEA from the people of Ukraine and Belarus, the republics most affected by the accident. The IAEA didn't help matters by derisively labelling as "radiophones" those who were genuinely attempting to draw attention to the accident's health effects.

To battle over the body count misses the point: Is not one victim enough to condemn a reactor design long known to be deficient? However, the IAEA attitude has been characterised by Deputy Director Rosen's careless statement at Vienna conference in August 1986: *

"Chernobyl shows us that even in a catastrophic accident, we are not talking about unreasonable numbers of deaths."

Alexander Sich
Bulletin of Atomic Scientists

Verdict on Health: Plenty to Worry About

As recently the summer of 1994, the British Medical Journal was headlining its editorial on Chernobyl "Probably nothing to worry about".

Unfortunately there's plenty to worry about: Scientists were expecting that the first disease to appear would be leukaemia since that is what had been observed amongst the Hiroshima and Nagasaki survivors. Everyone is now agreed that, although childhood leukaemia have not shown that sharp an increase, there is a dramatic and increasing incidence of thyroid cancer in the most contaminated areas.

Several scientific meetings were organised in connection with the 10th anniversary of the Chernobyl disaster. The World Health Organisation (WHO) planned the first of this series from November 20 to 23, 1995 in Geneva. At this conference, results of the "International Programme on the Health Effects of the Chernobyl accident (IPHECA) pilot projects, and related national programmes, were presented.

Who are the affected?

Those affected fall mainly in two categories. One are the liquidators- the men and the women called in to clean up immediately after the accident. They should be the first to feel the effects from Chernobyl. Studies reported to the WHO from Ukraine and Belarus are beginning to suggest that cancer is increasing among them, but the results are far from conclusive. No one even agrees how many liquidators there are. The WHO figures of 800,000 was briskly dismissed as grossly exaggerated by Leonid Ilyin from the Russian Federation Ministry of Public Health. Ilyin says the real number was closer to 200,000.

One of the reasons why such a large force was conscripted to decontaminate the reactor surroundings was that the neighbouring units I, II, and III could continue to produce electricity since Chernobyl was one of the largest electricity generating station in the Soviet Union. Liquidators are under permanent stress, especially as nobody is in a position to indicate the actual consequences for their health because of their engagement.

The other group are the more than 2 million inhabitants of the region around Chernobyl, living in contaminated parts of the three CIS-countries, Belarus, Russia, and Ukraine. Their situation differs from that of the liquidators. The intensity of irradiation may have been less than for liquidators, but the duration of exposure to radiation is much more prolonged, already a decade. The assessment on the actual risk for the population has to be studied by the medical community. Much less is known for such a chronic situation, compared with the risk following an irradiation limited in time. Chernobyl could give an opportunity to learn precisely the clinical risks associated with low dose radiation. The consequences of such studies will allow to take preventive measures in the future.

The epidemic of thyroid cancers is likely to continue for decades and involve many thousands of children. As many as 40% of the children exposed to the highest levels of fallout from Chernobyl when they were under a year old could go on to develop cancer as adults.

The Scale of the Problem

Dr. Valery S. Sorokine, from Russia, said that there were 80 million persons irradiated in the country. This figure includes persons living in areas of Russia where earlier accidents and routine dumping have occurred. Besides Chernobyl, there is the Altat, Chelyabinsk, Oural, Kazakstan, Kola, and many other territories contaminated by nuclear wastes, accidents or atomic explosions. In this country, control groups must be selected in clean zones, which may be difficult, as 17 million hectares are contaminated.

For Dr. Y. Korolenko, Minister of Health of Ukraine, 30 million inhabitants drink water contaminated with radionuclides. He indicated that 600.000 square Km. had to be abandoned, this includes fertile soils, and 40% of the forests of the country. Today more than one million persons are living in contaminated areas, with more than 5 Curie/square metre.

For the Vice-Minister of Health of Belarus, Dr. N A Krysentko, 23% of the national territory is contaminated, 2 million persons-including 410.000 children- have been or still are irradiated.

Millions of refugees exist worldwide. However, when evacuated from a radio-contaminated area, refugees cannot consider returning home for their life-time or a very long period. The absence of such hope affects hundreds of thousands; this has detrimental psychological consequences. Furthermore, the 200.000 refugees are aware that they have already been irradiated before leaving their homes, i.e. they are at higher risk than others of suffering from cancer or giving birth to deformed children. Unfortunately, nobody informs them accurately about the risks.

Thyroid Cancers in Children

Before the accident in the regions surrounding Chernobyl the annual inci-

dence in the children under fifteen years was 0.5 per million children (a similar incidence as in the UK). 680 cases of thyroid cancer have now been confirmed in Belarus, Ukraine and Russia since the accident; the cases are concentrated in an area where rain deposited the heaviest iodine contamination, more than 200 kilometers north of Chernobyl. The incidence in the Gomel region of Belarus is more than 100 per million. The epidemic is likely to continue for decades and involve many thousands of children. According to Dillwyn Williams of Cambridge University, as many as 40% of the children exposed to the highest levels of fallout from Chernobyl when they were under a year old could go on to develop cancer as adults.

Iodine deficiency

The exact cause of the increase in thyroid cancer is still not clear. The incidents in children born more than 6 months after the accident seems to be much lower, suggesting that early inhalation and ingestion of radioactive iodine were responsible. It is not clear at present whether iodine-131 is solely responsible, or whether other short-lived isotopes (iodine-130,132, 133 and 135) are implicated too; the amount of iodinc-133 released was almost a third of that of iodine-131. Uptake of radio-iodine was further increased because regions surrounding Chernobyl are deficient in iodine, and iodine deficiency disorders (e.g., goitre) are common; and for the same radio-iodine intake, an infant would receive about ten times the absorbed thyroid dose as would an adult.

The surgery of such cancers is devastating, with the risk of harming the parathyroid glands. As a consequence, treatment of children with thyroidectomy is very difficult, and costly. This represents a dramatic health problem for countries in severe economical crises. If there exists a concomitant deficiency of parathyroid hormone, the therapeutic measures to be taken become even more problematic.

The atomic industry promoters, claim that thyroid cancer is the only neoplasm associated with the accident, and furthermore that this kind of cancer is usually not lethal, because it is easy to treat. This is contrary to the truth and cynical. Treating malignant and endocrine diseases in small children is much more difficult than treating the same condition in adults.

Some scientists assumed that the increase in thyroid cancer was just due to 'ascertainment bias' (i.e., the harder researchers look for an effect, the more likely they are to find it). There has been a reluctance on the part of some scientists, particularly in the US, to accept that iodine-131 is the cause, partly because there is no clear evidence of iodine-131 having caused thyroid cancer when used therapeutically, as it often is, to treat overactive thyroid. However, there may be a big difference between giving large doses of iodine-131 to an adult, diseased thyroid - with the object of killing as many of its cells as possible -and low doses to the normal thyroid of an infant or child, where the potential for mutagenic effects could be far greater. More worrying, it has been suggested that government scientists in the US may want to play down the effects of the release of iodine-131 because of the large quantities released from the Hanford nuclear site in the 1940s.

'Good' Cancer Propagandists

The atomic industry promoters, claim that thyroid cancer is a 'good' cancer since it is usually not lethal, and it is easy to treat with replacement therapy. Unfortunately, it is difficult to treat afflicted children anywhere, especially so in countries where the accident and social disruption, has meant a severe shortage of funds for medicines and medical services

One reason that seems to make ascertainment bias unlikely is the aggressive nature of the disease; affected children quickly become unmistakably ill with secondary cancers in the lymph nodes of the neck and lungs. Treatment can be high doses of iodine-131, but obviously administering yet more radioactivity is difficult. The alternative is surgery, but there is a problem here too: it is usual in thyroid cancer to remove the whole thyroid, but the scarcity of thyroid replacement hormone has made some surgeons reluctant to do total thyroidectomies; instead they remove only part of the thyroid, which may miss some of the cancer cells.

Whatever the exact mechanism responsible for the increase in the thyroid cancer, at least one thing seems clear: the recommendations and arrangements for iodine prophylactics in future accidents have to be looked at very carefully. For the thyroid, the National Radiological Protection Board specifics a low 'emergency reference level of 30mSv - if the predicted dose to the thyroid is likely to exceed this, administration of prophylactic iodine may be justified. If the predicted dose is above 300mSv, prophylactics is deemed essential. As a result of the Chernobyl experience it has been argued that the lower limit should be reduced to l0mSv, at least in children.

What further cancers can be expected in those most exposed? The World Health Organisation (WHO) points out that the tissue most sensitive to radiation exposure, in addition to the thyroid and bone marrow, is the breast of the young women; populations within 100km would be particularly at risk, and we may expect a rise in the incidence of breast cancer. Effects of airborne radioactive particles on the induction of skin and lung cancers is also a matter for concern. And the 'liquida-

tors' - about half a million people, mostly young men, who cleaned up.after the accident - are reported to have an increased incidence of cardiovascular disease, not normally associated with radiation exposure.

Other Non-Cancerous Effects

Several researchers from the former Soviet Union argue that radiation from Chernobyl is also causing increases in a range of non-cancerous diseases. Alexei Okeanov from the public health research centre in Belarus, for example, says the Chernobyl accident is responsible for an unqualified increase in the rate of cataracts, cardiovascular disease and hyperactive thyroid glands. The link between radiation and cataracts has been well established by studies of Japanese A-bomb survivors. But Western researchers have been sceptical of links with other non-cancerous conditions because they do hot have a well understood causal link.

However, a new study of the A-bomb survivors presented in Geneva provides the first serious evidence that radiation may help to trigger strokes, heart disease and cirrhosis of the liver. Direct correlation between radiation exposure and all three conditions are highlighted by researchers from the joint US-Japanese Radiation Effects Research Foundation in Hiroshima. They also reveal evidence that hyperactive thyroids and non-malignant tumours in the uterus, ovary, stomach and thyroid.

"We are now almost sure that non-cancerous diseases have increased among atom bomb survivors," says the head of the foundation, Kazunori Kodama. "But we need extensive studies to discover "why." One possible clue is that cholesterol level in the blood, which is a risk factor for strokes and heart disease, are higher than average among A-bomb survivors.

Increasing Mental Retardation

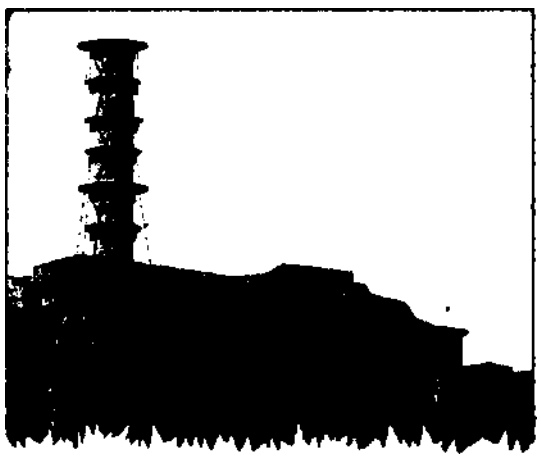
More disturbingly, evidence is emerging that radiation may have damaged the developing brains of foetuses in the womb. The WHO is sponsoring a study to compare the cognitive abilities of 2189 children born in contaminated areas. Preliminary findings suggest that children from the contaminated areas are suffering more mental retardation, more behavioural disorders and more emotional problems.

According to one the project's researchers, Irina Kozlova from the Russian Academy of Medical Sciences, half the children irradiated in the womb have experienced "some kind of mental disorder". A higher than average proportion of them, she says, have an IQ lower than 70, which suggests they are likely to be mentally retarded. Precise figures will not be known until the research is completed. Kozlova thinks that even very low levels of radiation could damage neurons in the brain of a foetus.

"We cannot rule out the effects of radiation on the developing brain," agrees another researcher from the WHO study, Anagelina Nyagu from the Ukrainian Academy of Medical Sciences. "The problem of prenatally irradiated children is unfortunately going to be priority." These findings reinforce those from Hiroshima, where 1100 children exposed to radiation in the womb also suffered a higher than average rate of mental retardation.

Thousands of adults have also experienced psychological problems in wake of Chernobyl, but not because their brains have been harmed by radiation. Uncertainties about radiation risks, coupled with the social dislocation provoked by large-scale evacuation programmes, cause anxiety and stress. Real or imagined health worries, loss of homes, changes in jobs and financial difficulties precipitate depression.

Terence Lee, professor of psychology at St. Andrews University, says that people around Chernobyl feel powerless and fatalistic, a condition he calls "chronic environmental stress disorder". The solution is to give them reliable information about the risks of radiation from sources they trust, he says.



"The atomic Mafia seem to believe that the problem can be solved by slides showing multicoloured entrails of nuclear reactors, but this is of course to no avail."

Birth Defects

Very few studies have been done on this subject. Prof. G. Laziuk has described genetic anomalies in new-born: amelia and polydactylia increased. This increase is not directly proportional to the dose received. To reduce the number of malformations, pregnancy interruptions became more frequent: from 12.5 to 17.4/1000 between 85 and 94.

It has been published that malformation in pigs and calves have increased by factors 100. In some places, it is no more possible to breed pork, as there are too many malformed offspring.

Research Effort in Absolute Chaos

Distinguishing between disease caused by radiation and disorders provoked by stress is just one of the problems faced by researchers. Obtaining a clear picture of the health effects of the accident has been hampered by the disintegration of the Soviet Union and clash between Eastern and Western European scientific cultures. According to one senior researcher, the entire international research effort "is in absolute chaos".

Insiders say that, instead of collaborating, research institutes in Belarus, Ukraine, Russia, Europe, Japan and

America are competing for the same limited set of health data. Some researchers allege that political differences, national chauvinism and the egos of individual academics are preventing serious co-operative science. International collaboration, admits Baverstock from WHO, is "disgracefully poor." As a result research is fragmented and its conclusions often disputed. Baverstock points out there is no real, mechanism for exchanging information. He is pessimistic about whether collaboration will ever improve. The credibility of the international scientific community is at stake, he says.

Dr David Sumner
Chernobyl: Ten years on,
Safe Energy Journal

Preparing for the Next Chernobyl

For most people in the world, one Chernobyl is enough. But there is a lobby which is so addicted to nuclear power and believes that it is such a wonderful source of energy that it cannot under any circumstances think of abandoning this madness. When questioned as to the number of fatalities the accident had caused and the impact of the accident on Soviet society and Soviet nuclear industry, A.M. Petrosyants (then chairman of Soviet State Committee on the Utilisation of Atomic Energy) responded: "Science requires victims." M. Hans Blix, (the long time chairman of the International Atomic Energy Agency (IAEA) and a well travelled spokesman for this lobby)declared in 1986 that "due to the importance of this source of energy, the world could support one accident of the Chernobyl scale every year...."

It is against this background of cockeyed conviction that one must examine the bizarre contributions of the nuclear lobby. The International Atomic Energy Agency (IAEA), the UN body responsible for promoting and policing nuclear power, argued that government decisions to evacuate more than 135000 people and to impose widespread restriction on farming and food consumption harmed the lives of "hundreds of thousands, if not millions of people".

Belarus Authorities Let People Return to Chernobyl Territories

Authorities of the Belarus Republic have launched a campaign to return people to regions which have suffered from the 1986 accident. The campaign was begun after Belarus President Alexander Lukashenko declared upon visiting the Chernobyl territories that people should return to abandoned lands. Soon thereafter, the president's Academy of Administrative Management developed an unusual document entitled "Programme for improving public information on problems of Chernobyl and radiation safety."

The document states that public consciousness exaggerates the consequences of Chernobyl accident. One item of the action plan calls for directing public attention to positive factors by propagating positive information.

The program also foresees a campaign to influence top officials in the media and to influence the public through the media. The authors specify the use of works such as "Psychological warfare" and "Manipulation of consciousness." State newspapers are already working according to this programme.

The new Chernobyl policy is based on conclusions of government scientists that over the past 10 years, Chernobyl—contaminated territories have been substantially cleared of risk due to natural radioactive disintegration. This conclusion was also the basis for the government's decision to rehabilitate the abandoned lands. According to data from the Emergency Ministry, 6,000 hectares of contaminated territories are already in use.

The director of the Institute for Radiation Safety, Academician Vasiliy Nesterenko, believes Lukashenko has made a serious error. Nesterenko points out that the official physicists have based their reasoning about radioactive disintegration only on strontium and cesium, ignoring other radioelements. He believes development of the contaminated territories is premature at this time. Nesterenko notes that about 70% of the radioactive particles emitted by Chernobyl-4 fell on Belarussian territories.

Nevertheless, the resettlement campaign is going forward, primarily because j of the country's economic crisis, unemployment, and shortage of arable land. People are coming back to the Chernobyl zone, where there is work for them. Last year, crops were harvested on developed lands. This year, it is planned to expand the arable land by a few thousands hectares.

Peter Coryn, Chernigov, Ukraine
Nucleonics Week

The IAEA claims that radiation exposure will result in a marginal and probably "undetectable" increase in cancer. Cases of thyroid cancer will amount to "a few tens in a million per annum". Last year, the number of children in Gomel who contracted the disease reached 240 per million.

Filthy Lucre Ahead by a Mile

The objective follow-up of populations after the Chernobyl catastrophe, should have given the world an opportunity to improve our knowledge about the risks at low doses. Studies performed during the last decades, have shown that earlier dose limits were always set too high, and that lower limits would be safer. But in this competition between sound health of large populations verses the bulging pocketbooks of some, il is the greedy who art winning. "Experts" have already decided to increase limits of accepted contamination of water and food, before data becomes available from conclusive studies.

Politicians and experts supporting atomic energy, including those of IAEA, and experts from France, intend to change the official limits for radioprotection. These experts wish to change rules so as to reduce the immediate cost of future accidents. For the promoters, the limits assigned after Chernobyl accident have to change, in the sense that much higher radiological contamination should become legally acceptable.

Furthermore, the contamination labelling needs to become so complex that grocers or border guards will not be in a position to decide by themselves if milk, meat, or vegetables are safe or not to be given to children or adults. Instead of "Becquerels per kg." of food they now want to subdivide this into Becquerels for each individual radionuclide: Caesium, strontium, etc. This require new apparatus. Globally, however, the aim is that contaminated food be considered less dangerous than it is today. Again, the aim of such changes is to reduce the responsibility of nuclear industry, and reduce the cost of preventive measures for the "next Chernobyl."

Dr. Michael Fernex

The Tricks of *the*

The general aim of epidemiological trials is to find out if an event has health consequences. However, if experts begin with a motive of not wanting to demonstrate consequences, inadequate studies can be undertaken which will 'prove' that effects do not exist. Such studies usually suffer from the following sources of error:

- Selection of wrong health indicators: e.g. mortality instead of morbidity.
- Screening for the wrong pathology: e.g. ignoring leukaemia, digestive, lung, mammary carcinoma.
- using the wrongtiming: e.g. ignoring long incubation period, then declaring "10 years after Chernobyl, nothing more can be expected. We know how to manage the next accident."
- selecting the wrong target group: e.g. not studying the most susceptible group or not selecting the group with the highest exposure.

Having thus selected either wrong methods or wrong targets or both :

- the results will show no statistically significant difference with any control group.
- the conclusion will be that the hypothesis was wrong.
- the consequence will be that the authorities will be convinced that everything is under control and business as usual can proceed.

Revittimtsatlon:
A sorry tale with no *ending*
Three Mile Island, Bhopal and Chernobrl...

"There is no free lunch. Somebody has to pay the price of development." How often have we heard this from those who pay no price at all for anything. But that is a different tale. To the victims, development is not a good whose price is paid once but an unending nightmare which demands an undefined, unbounded payment which continues on and on.

Take the Three Mile Island accident for example. On 31st March 1979, a stuck valve started a series of events which culminated in a partial melt-down of the nuclear reactor. Fortui-tously, the accident did not result in a

huge explosion with a large release of radioactivity to the environment, but nevertheless there was radioactivity release to the environment in excess of prescribed 'limits'. People living near the reactor did suffer harm. Infant mortality and spontaneous abortions, congenital deformities in both humans and animals in the region rose in a significant manner. But to the nuclear authorities, these were of "no concern to the community." More than 2,000 victims of this disaster have filed court cases against the owners and operators of the plant, but they got their chance to tell the Court about their injuries and sicknesses only in June 1996, that is fully 17 years after the disaster. On 27th February, 1996, the United States Supreme Court turned down the argument of the nuclear industry, put forth by the owners of the reactor with the support of their nuclear "experts" in the industry, that even though the radiation exposure of the people was above federal limits no one was actually exposed to "excessive* radiation and therefore no one experienced radiation detriment. Most of these court cases involve leukaemia, or other cancers, and most of the victims are destitute; the inevitable result of having lost employment and health insurance. Nevertheless, the nuclear industry has relentlessly pursued the loop hole which it saw in an earlier Supreme Court's ruling: that for expert testimony to be admissible in the court, its scientific basis had to be generally accepted in the relevant scientific community. Using this criterion, the nuclear industry challenged all the expert witnesses which the victims had found willing to assist them in their suit against the nuclear management which had caused the disaster. In pre-trial hearings, the nuclear industry managed to have the court eliminate almost all of the victim's expert witnesses. The nuclear 'experts' who work for this industry were considered by the court to be the "relevant scientific community", and only the documents produced by nuclear promoters such as the International Atomic Energy Agency (IAEA) as "authoritative".

It is good to remind ourselves that all this has happened in the United States-a country which prides itself as the home of "freedom and democracy". After this it should come as no surprise to victims of Bhopal, that their sufferings are not heard and the few crumbs thrown as "compensation" are all that they are going to get from relying on the conscience of the corporate tycoons and their Indian collaborators. In Bhopal the bodies of the victims lined the streets and (he disaster was apparent to everyone, but in a radiation accident like Chernobyl where death stalks slowly over the years, revictimisation means that victims are not recognised as victims at all. Thus, while the Ukrainian health ministry says that 125,000 people died due to the accident, IAEA still sticks the ridiculous figure of 28 deaths.

By use of very restrictive definitions, most of the illnesses and health problems which are actually experienced by the victims of a disaster like Chernobyl are not counted

This jugglery is done through restrictive definitions of dose and risk. Thus, distinction is made between dose due to the "accident" and doses due to clean-up. For example, the dose may be defined as only that received in the first seven days, and even that amount will be reduced by the dose expected to have been received in the course of normal operation of the reactor. Death due to radiation exposure requires a dose estimate for • the victim above the threshold and death must occur between the exposure and 30 days thereafter.

Similarly, radiation detriment to health is divided into two categories:

Deterministic effects of radiation: This category of damage is considered to be evidenced by radiation burns and acute radiation sickness, such as was experienced by the firemen at Chernobyl. Detriment is based on the overall effect to the group, not the individual. Any effect not felt by everyone in the group, is classified as reversible, transient and of no concern to the group and hence not included in the detriment.

Stochastic Effects of Radiation: these include those effects which occur with statistical regularity in the exposed population such as cancer and genetic effects. These have no threshold. In order to ensure that these are radiation induced, nucleocrats recommend not counting any which have not had a "normal" latency period which is ten years for most cancers, and are not severe genetic effects in live-born offspring. Radiation promoted cancers arc not recognised as radiation related. Genetically damaged offspring who die in ulero are said to be of no concern to the community since they do not cost the community financially.

By use of these very restrictive definitions, most of the illnesses and health problems which arc actually experienced by the victims of a disaster like Chernobyl arc not counted or do not exist for the nuclear promoters. Automatically excluded arc: direct damage to tissue which results in altered biological function, like changed blood parameters, hormone or enzyme production, etc. Most evident in exposed children; embryonic and foetal death; genetic diseases not deemed "serious" like asthma, teratogenic damage including mental retardation, epilepsy, bone deformities, blindness and deafness, radiation promoted cancers which are clinically diagnosable in less than ten years after the disaster and autoimmune diseases.

With such preparation, is it any surprise, that the IAEA meeting on "Ten Years of Chernobyl" found that the disaster had had no consequence at all and recommended that governments of the region move people back to contaminated land?

Surendra Gadekar

Fighting for the straps

When International Atomic Energy Agency (IAEA)inspectors visited Bulgaria's Kozloduy station in 1991, they encountered missing stairway steps and gaps in walkway gratings. One inspector fell through a hole, bruising his leg. Railings around pools were missing, as were light bulbs and fixtures. Windows were broken, pumps leaked steam, and pools of oil and water were everywhere.

Western nuclear vendors could easily imagine that a serious nuclear accident in Central Europe or the Balkans would spread fallout over the major population centres of Europe, and they decided something should be done. At a June 1992 summit, the G7 industrial nations organised emergency measures to reduce near-term safety risks and to assess the feasibility of closing down the most dangerous Soviet-style RBMK-1000 and other VVER-440 reactors. The loss in generating capacity would be balanced by improved energy-use efficiency and alternate energy sources. Western nations, the European Union, the IAEA, the Organisation for European Cooperation and Development, and the European Bank for Reconstruction and Development (EBRD) pledged more than $785 million to improve safety RBMK-1000 and VVER-400 and -230 units. But five years later the only reactors to have been shut down are those inherited by the newly reunified Germany. Elsewhere in Eastern Europe, closure of the most dangerous and accident-prose reactors has been delayed indefinitely, although safety has improved at some plants.

I *Wanna Hold Tour Hand*

Western nuclear suppliers got a new lease on life with orders for everything from training support to new instrumentation and control centres and waste-storage buildings.

Ironically, Western-funded short-term safety improvements have encouraged the continued operation of the most dangerous reactors-at places like Kozloduy, Slovakia's Bohunice, Chernobyl , and Russia's Kola. Meanwhile, Western contractors like Westinghouse and Siemens have forged links with Eastern Europe's state-run utilities, most of which operate as subsidiaries of state energy ministries.

In 1993, Westinghouse invited four high Ukrainian energy officials to tour US reactors and discuss the possibility for joint completion of unfinished Ukrainian plants. ."We are children in the world economy, but we know what needs to be done," the head of Ukraine's parliamentary committee on science and technology, Pavel Kislyi, told *Energy Daily*. "We need a company like Westinghouse to hold our hand."

Nuclear colonialism?

Now most countries in the region are planning to extend their nuclear generating capacity, either by purchasing new Western-designed plants or by completing reactors left unfinished under communism. Last January, Atomic Energy of Ganada completed the first of the five reactors that were planned at Cernavoda. Westinghouse is working with the Czech utility CEZ to complete two Soviet-designed VVER-1000 reactors at Temelin, near the Austrian border. Electricite du France and German utility, Bayernwerk, had planned to complete Slovakia's unfinished Mochovce plant, which is equipped with second generation VVER-440s. Ukraine has conditioned the closure of Chernobyl on a wide-ranging package of Western aid designed to help Ukraine update its power systems, and finish three VVER-1000s. Hungary, Bulgaria, Poland, and Lithuania are all considering expanding their nuclear capacity, and Russia has announced a plan to double nuclear power generation by the year 2010.

Western governments are supporting these plans by providing loan guarantees. The US Export-Import Bank has committed $317 million for Westinghouse's work at Temelin; Canada loaned $270 million for the Cernavoda project; and, at one time, the EBRD had promised DM 700 million to Mochovce. By 1993, Friends of the Earth, an environmental group, reported that Western governments and institutions had committed twice as much money to completing unfinished Soviet-style reactors as they had to improving safety at operating reactors.

Because so many Eastern countries lack the financial resources to pay for their new nuclear capacities, building loans may be paid off by exporting some or all of the electrical output. For instance, Hungary has invited bids for 2000 megawatts of new capacity-twice its projected need. A West European partner could receive deliveries of electricity without the risks of operating, fuelling, or decommissioning the generating plants. Such a plan would also allow a West European government to dodge the public opposition to nuclear power that has suffocated most Western programs.

Meanwhile, the Eastern partner would be responsible for operational and incidental costs, including the costs of fuel and waste disposal, new transmission lines, and hundreds of power plant employees. At the end of the plant's lifetime, the Eastern partner would have to bear the costs of decommissioning, which alone can add at least 3Q percent to the initial cost. Not just construction, but many of the "downstream" activities would require the services of Western consultants and suppliers.

"It's one of the last markets in the world for the Western nuclear industry," says Paxus Calta, an anti-nuclear campaigner for the Vienna-based environmental group Global 2000, who believe that Western and Eastern nuclear interests have formed an unholy alliance.

"The Eastern nuclear establishment is very interested in maintaining their monopoly power, avoiding privatisation, stopping market reforms, maximising profits, and maintaining the options for kickbacks and corruption."

Communist party planners turned to nuclear power as the basis of their long-term energy strategy in the mid-1970s, when the price of Soviet oil and gas increased. Bulgaria was to have more than a dozen reactors by 2005; Czechoslovakia, 30; Poland more than 20; and Hungary and Romania, half a dozen each.

Some of these projects were never started, but of the others, many plants were left unfinished. Millions-sometimes billions of dollars have been invested in them. The engineering and professional organisations that would have built, operated, and supplied the reactors-big firms like Skoda-Plisen, Russia's Atomenergo-export, and even smaller ones like the Vatra Dornei uranium mines in Romania-have a great deal of political influence.

And the organisations that, operates the existing reactors that provide 80 percent of Lithuania's electricity needs, half of Slovakia's and Hungary's and a third of Slovene and Bulgarian supplies, wield commensurate political leverage within the energy sector.

Double Standards

The main break on Western suppliers' enthusiasm is the issue of liability. Most East European countries have not yet signed the Vienna Convention, which holds the operator, not the supplier, of a nuclear facility responsible for damages in case of accident. Western suppliers do not want to be liable for billions of dollars if a plant they help to built suffers a serious accident. "It's a pressing issue for them," says IAEA spokesman David Kyd. "Until the liability issue is resolved, their legal departments are advising against involvement."

Completing of retrofitting Soviet-designed plants carries an extra degree of risk. Western assistance to complete Temelin and Mochovce has raised the issue of a double standard for reactor safety. A newly reunified Germany acted quickly to close the VVERs at East Germany's Griefswald plant, which were deemed unsafe and not upgradable. As late as 1995, however, the EBRD, Electric de France, and Bayernwerk were helping to complete Mochovce's reactors, which are identical to those at Griefswald.

Bayernwerk head Wild admitted in a 1994 newspaper interview that a plant like Mochovce could not be operated in his country: "Certainly no one would permit this kind of installation in the. surroundings of Munich." Similarly, Germany concluded that the nearly completed VVERs at Stendal could not be brought to acceptable safety levels, and that plant-which, paradoxically, is identical to the facility at Temelin in the Czech Republic-was also decommissioned. Meanwhile, backed by US government loans, Westinghouse is completing Temelin.

One problem with VVER-440 series reactors like those at Mochovce is there lack of containment. Experts interviewed for this article-including the head of nuclear safety research at a US Energy Department laboratory and the Canadian site manager at Cernavoda-agree that it is not feasible to backfit the reactor with containment, and that without such a structure, these plants would not be allowed to operate in North America. Temelin and Machovce-both less than 100 kilometers from Vienna-have been opposed by Austria, which has waged a stormy campaign against projects that it considered unacceptable risks to its citizens. Austria's threat to withdraw from the EBRD over the issue contributed to the bank's decision to abandon financing Mochovce.

Waste Not Want Not

Safety issue aside, mounting evidence suggests that nuclear power is not the solution to the region's energy needs. "We have an extremely energy-intensive economy, and we already have surplus generating capacity," says former Czech Environment Minister Bedrich Moldan. "If you have such a big investment as Temelin, it will [deplete]the limited resources available for addressing the outrageous inefficiencies in our energy system."

"The Eastern nuclear establishment Is very Interested In maintaining their monopoly power, avoiding privatisation, stopping market reforms, maximising profits, and maintaining the options for corruption"

There's plenty of room of for demand-side improvement. By subsidising energy and raw materials, and driving for increased industrial production, communist planners created a system plagued with waste and inefficiency. Poland uses two to three times as much as energy for the same output as West European countries; Romania, three to five times as much. Electricity is produced, transmitted, and consumed in a wasteful manner-homes lack thermostats, buildings and heating ducts are improperly insulated, and antiquated machinery and power plants squander vast quantities of energy.

"There is enormous potential for energy efficiency gains," says Diana Vorsaz, a Hungarian energy expert at Central European University's

environmental science department. "It's absurd to try to address the problems in our energy sector through increased supply. Demand can be reduced at a fraction of the cost while improving our economy and competitiveness." Vorsatz estimates that as. much as a third to a half of current consumption could be saved.

However, even if the West should decide not to help complete questionable plants, Russia may. After the EBRD abandoned Mochovce last year, Russia's Minatom stepped in. Slovak officials have backtracked on their pledge to close older, more dangerous units at Bohunice, and they have grown weary of Western scrutiny of safety upgrades and least-cost studies. Russia and a consortium of Czech banks are offering to help complete Mochovce at a fraction of cost.

A recent study by Centre for Strategic and International Studies warns that Minatom is emerging as an aggressive exporters, citing Russian activities in Iran, Cuba, and India.
Belarus may choose. Russia's Soviet-style reactors because they are less expensive than Canada's CANDU-6. Meanwhile will successfully market its plants in China

It looks like nuclear power plant inspection will be. a growing field.

By Colin Woodard
Bulletin of Atomic Scientists May June 1996

The Belarussian Necklace

Four frightened young girls
Waiting for their turn
Will it hurt? Will I survive?
The lessons quickly learned
They lie there in their beds of fear
It could be you or me, but they must pay the price
For man's inhumanity.

Four frightened young girls
Want to live their lives
Want to find a sweepheart
Want to be young wives.
They want safety for their children
In a land that's free from fear
They. want to love and life and laughter
And a future they can face
With their children's necks unblemished
Not a Belarussian red necklace

Mags Whiting

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