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POLICY RESPONSES TO LARGE SCALE ACCIDENTS IN THE SOVIET UNION

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Large Scale Accidents: A Growing Problem For the Human Race and the USSR

A number of the large scale accidents that have taken place in the world in recent years manifest once more the controversial character of both economic growth and technological change. Contributing to productive growth, improving labor and living conditions, enhancing material well being and the intellectual capacities of many countries, these processes also give birth to many hazards which jeopardize societies. Of particular importance are the risks connected with complex technological systems.

It is easy to cite many major and well publicized examples of this kind. Prominent would be accidents at nuclear power plants (NPPs) in the United States and Europe as well as Chernobyl in the Soviet Union; chemical poisonings as at Bhopal in India and from the chemical spill at Basel, Switzerland; the explosion of the Challenger spacecraft; the pipeline accident near Ufa in the Soviet Union as well as several large scale railway accidents at Arzamas and Sverdlovsk in the same country; and the loss of large passenger carrying ships such as the Admiral Nakhimov and the Lermontov in the Soviet Union which led to many deaths.

The accidents mentioned above as well as others less prominent that have taken place in various parts of the globe have resulted from different conditions, but they all have one thing in common. They illustrate the point that saturating the production and service sectors of societies with modern technologies lacking adequate safety measures will lead to a sharp rise in the "price tag" as a result of a technical failure or a human error. For even the availability of the best equipment with multiple redundancies and other safety devices does not guarantee a 100 percent performance reliability.

There ia also evidence that even with increasing reliability of technological systems, the absolute number of large scale accidents keeps rising. Those taking place at Soviet NPPs may serve as rather typical examples even though they are not the worst that could be cited. For nearly 40 years before 1986 there were predominantly insignificant incidents at Soviet NPPs; they did not lead to serious consequences.

But the Chernobyl accident because of major negative economic and ecological negative effects resulted in a national disaster. The melting of the reactor, the ensuing blast and radiation spread led to the almost immediate death of 30 persons, the hospitalization of over 200, and the evacuation of 116,000 people from nearby areas. The total direct material damage has been officially said to be over eight billion rubles or 0.7 percent of the Soviet Gross National Product (Diagnoz Poslye Chernobylia, 1988:3). The figure concerning the number of victims is considered constant by the VIPs of the Health Service in the Soviet Union and recently was repeated by Academician L. A. Ilyin in Paris (Financial Times, 1991).

As a different kind of example I should like to note that in recent years there has been an increase in railway accidents. Despite a decrease in real numbers of serious accidents and victims per transportation unit (or mileage), as well as in material costs and losses, the risk of various types of technological accidents and damages resulting from the carrying of hazardous materials in the Soviet Union--toxic, explosives, etc--has increased. As the direct result of only two train accidents at the Arzamas and Sverdlovsk rail stations during the transportation of explosives in 1988, nearly 100 persons were killed, and about 300 were injured (some of them were severely wounded). The material losses in the Arzamas accident alone exceeded 100 million rubles. Even more serious losses were suffered as a result of major railway accidents which took place at the Kamenskaya rail station in 1987 and at the Bologoye station in 1988; there were more than 130 deaths as well as a number of injured persons. About 450 persons also perished in the shipwreck of the Admiral Nakhimov liner.

The damages resulting from major accidents are not limited only to dead bodies and heavy property losses. There can be substantial socio-ecological impacts, these being particular important when produced by chemical plants or nuclear power installations. One effect of the Chernobyl NPP disaster was that a large area of the Soviet Union territory of 140 ,000 sq. kilometers was radioactively polluted to a degree of more than one curie per sq. kilometers. According to some estimates, a spatial area with a radius of more than 2,000 kilometers and covering nearly 20 countries--including 131 thousand of square kilometers in the USSR alone--has been affected by radionuclides (Porfiriev, La Croix, 1991: State of the World, 1987: 59). (also see attached map).

The potential carcinogenic consequences of the Chernobyl disaster is of particular concern because the cancer mechanism which may be involved has not been adequately researched. According of an official estimate made by L. A. Ilyin, the possible theoretical growth of cancer cases among the population of the USSR, in particular in its European part, induced by the accident may reach hundreds of percentages in addition to the average figure of cancer occurrence normally expected in the next 50 years (Diagnoz Poslye Chernobylia). Similar data have been cited by Professor R. Gale from the University of California. According to his calculations, the Chernobyl disaster in the next 50 years could bring an additional 15,000 deaths (or 0.025 percent of all cancer related deaths). He also believes that a number of negative teratogenic as well as mutagenic effects for the same period would be less than 700 and 1,900 cases respectively (Tochka Vo Vjellei, 1988). These figures correlate well with the calculations by L. A. Ilyin which suppose that the probability of mutagenic effects will constitute only one third of potential cancer cases. My personal guess is that these figures are the tip of the iceberg; estimates display that even today the death toll of Chernobyl should be measured in approximately one thousand victims (La Croix, 1991).

It should not be forgotten that from a humanitarian viewpoint even a single case of human death is a tragedy, not to say 15,000 possible cases. It should also be noted that the accident at Chernobyl resulted in negative psychological effects, in particular in an increase in real stress effects and not simulated radiophobia. Also, I should express my doubts in the official figures concerning economic losses mentioned earlier. Assessment performed by Professor Koriakin and myself prove that gross costs suffered by the USSR due to Chernobyl equal to an average 13-14 billion rubles per year, or to 200-250 billion rubles in 1986-2000 (Pozharnoye Delo, 1990).

Risk and Emergency Management: Changes in Policies

The various negative consequences for the population and the economy from large scale accidents indicate the necessity of rapidly developing and implementing a series of measures aimed at the mitigation of technological hazards as well as preparations for, responses to and recovery from their repercussions. These kinds of measures can tentatively be divided into two categories: preventive (or mitigating) and operational.

In the Soviet Union the former has been developed and introduced into practice primarily by higher level governmental ministries and departments of the industries responsible for potentially hazardous systems (that is NPPs, chemical plants, LNG terminals, gas/oil pipelines, dams, etc.). These measures have also been developed by civil defense units, local authorities as well as by relevant departments of trade unions.

The decrease in safety which has occurred is a manifestation of the problems and errors in management processes. This will require some reorganization. These matters will now be examined with NPPs being used as the prime example.

After the Chernobyl disaster, the Soviet government undertook several organizational measures to mitigate negative consequences from and to introduce reform measures into energy production and to make it less risky. In 1986, the new department of Nuclear Power Industry was established and given the full responsibility for establishing a technological policy for the industry. This included the building of NPPs in various parts of the country. Earlier, these functions had been undertaken by the Energy Department. The new initiative again indicated the willingness of the government to maintain or even to increase the role of nuclear power in fulfilling the needs of the Soviet economy for energy. As to the formulation of technological policy in the nuclear power industry, as well as Research and Development policies in this area also, the issue remained the prerogative of the USSR State Committee for Nuclear Power. The supervision and inspection of NPPs is now in the hands of the State Nuclear Power Plant Inspectorate (Gospromatomenergonadzor) organized by the State Energy Control Service (Gosenergonadzor).

The new organizational structure led to a number of immediate measures which can be subdivided into two major categories. One of them includes measures aimed at mitigating the repercussions from the Chernobyl disaster. The intent is to maintain full control over the situation which resulted from the disaster until the time when all rehabilitation measures in the affected region will have been completed. This will take a considerable amount of time. For this purpose the Department of Nuclear Power Industry established special engineering units (formally called Kombinat and now changed to Pripyat) to coordinate activities relating to decontamination work. As to the quantitative character of these measures, by the mid 1988, twenty one million square meters of machines and surface apparatus had been deactivated, five hundred thousand meters of radioactive soil had been burned, and more than one million meters of earth had been used for the erection of dams to protect the Dnieper and Pripyat rivers. More than 600 villages have been decontaminated with the procedures being practically completed although the efficiency should be considered as low given the fact that the area treated constitutes no more than five percent of the affected territory. The town of Pripyat now is being cleaned up. Radioactive debris together with the soil has been collected and stored in more than 800 burial pits. Measures to abate radioactive dust have also been taken in a 30 kilometer zone which will remain uninhabitable for many years.

A system for radioactive monitoring of surface and underground waters and wells located inside this zone and adjacent areas has been developed and established although it can not be said to be totally exhaustive. The whole territory of the seriously affected area as well nearby areas in addition to food products at markets are also subjected to some radioactive monitoring. But the situation is much looser outside this area where the monitoring is very sporadic.

Another set of measures elaborated and implemented by relevant organizations in the Soviet nuclear power industry is oriented towards the restructuring of research and development, and of technological policies in the area. The process goes in several direction. This reflects a desire to introduce a system approach to the managing of NPPs.

A rethinking of the previous approach to NPP personnel training is another pivotal step now being taken. This involves the inculcation of more knowledge in the training process and a stricter reexamination of the capabilities of personnel. This is especially important given that the malfunctioning of the Chernobyl

NPP operators was a contribution to the disaster (though the major one was the result of erroneous reactor safety system design and safety instructions). Of course human error is a common element in many other accidents also both in the Soviet Union as well as elsewhere. According to some estimates, 45 percent of NPP accidents, 60 percent of air crashes, as well as 80 percent of accidents at sea are the result of these errors, mainly made by operators although they are not the only ones that may be at fault.

Stricter monitoring and control of NPP functioning is still another measure taken as a result of the Chernobyl disaster. The comprehensive analysis of the NPP at Rovno performed by the International Atomic Energy Agency experts in 1988 can serve as an illustration of this measure. After the Chernobyl disaster all experiments not included in the protocol of tests have been forbidden. As far as scheduled reactors tests that deal with power changes or fission termination are concerned, now they can only be performed in the presence of the chief engineer of the plant and an inspector from Gospromatomemergonadzor who literally stand near the NPP control panel. In addition, stationary rods have been inserted in all functioning nuclear reactors in order to prevent a possible chain of errors as happened in the actions of the Chernobyl NPP operators, though this measure should not be viewed as the most important and effective in terms of safety control.

Another change of direction in the research and development and the technological policy in the nuclear power industry concerns reactor design. This is with respect to reliability as well as control systems. As was mentioned earlier, drawbacks in the RBMK-1000 model along with those in the protective systems, contributed most of all to the major accident at Chernobyl. Therefore, decisions have been made concerning the RBMK-1000 model. In July, 1986, the Soviet government adopted a special regulation that prescribed the development of highly reliable, automated control systems designated for NPP technological processes manipulation. This action served as an impulse to commence work which has recently increased the speed of protection system performance as well as automated regime control of RBMK.

Nevertheless, taking into account better technological, economical and safety characteristics of LWRs, the USSR State Committee for Nuclear Power and the Department of Nuclear Power Industry have come to a decision: namely to suspend construction of RBMK-type plants and base future development on LWR type reactors. In addition, expert systems are planned to be introduced in NPP control and protective schemes.

Another policy response to the disaster at Chernobyl are new theoretical and practical approaches as concerns the deployment of NPPs. This involves stressing having a safety distance between them and large population settlements, avoiding high seismicity zones, etc. so as to have less risky situations in the future.

This approach for identifying appropriate places for new NPPs construction diminishes the risk of population exposure to potential radiological threats.

Two methods are used to bring this about. One of them involves the suspending or stopping of construction of NPPs where safety criteria can not be met. This has been done despite the fact that in many cases relatively large investment of resources had already been made. There was the stopping of the erection of NPPs in Krasnodar and a third power block of the Ignalinskaya NPP in Lithuania which had already cost 14 million and 260 million rubles respectively. The suspension of the erection of the nuclear heat plant being set up only 37 kilometers from the Byelorussian capital of Minsk in 1988 as well as the start of the Metzamor NPP in Armenia in 1989 (after the Spitak earthquake) are also dramatic examples of the current policy (Pravda, 1989). A related measure is a revision of the scheme of the deployment of future NPPs so that they will meet safety criteria.

Another policy response which can not be overestimated has been the establishment of vast and comprehensive medical monitoring of the population living in affected areas along with research on the psychological consequences of large accidents similar to that of Chernobyl. Besides the continuing of medical observations of affected persons, a number of new research and development and curative institutions have been organized in the Ukraine and Byelorussia. In the latter, a biomedical data bank of 155,000 persons has been established. The radiological exposure of the local population is being studied and health forecast have been made. Analyses covering the Mogilev and the Gomel areas of Byelorussia as well as the Kiev area of the Ukraine and Bryansk of Russia show rather strong correlations between cancer increase rates in these regions (e.g., for the former it has gone from 239 in 1985 to 267.8 per 10 (5) inhabitants) and the average national (all-union) figures (Argumenty y Facty, 1988). This supports an important idea which is that for the <u>early</u> postcrisis phase, a more or less pronounced trend of an increasing carcinogenic rate may not be typical, although such a conclusion in respect to low doses at impact for medium or long run effects does not rest on good grounds.

The last but not the least area of policy response to the Chernobyl disaster is manifested in the increasing role of citizen participation in discussions of NPPs development and deployment in the future. This trend is consistent with improvement in the field of risk communication to lay people, with the detailed data available to them from the Chernobyl disaster and its consequences, as well as the current radiological situation inside the 30 kilometer zone (although this information is far from being exhaustive). Along with this trend is the trend of growing attention to public opinion being given by the republic and federal governments. The refusal to continue construction of NPPs in

Byelorussia, the Ukraine and Lithuania as well as the suspension of the one in Armenia mentioned earlier is a manifestation of this trend. We can also note that shortcomings in NPPs deployment were heavily criticized in mass media stories by public representatives. The decisions of the central government to denounce a number of water resource as well as mineral resource development projects should also be noted as consequences of increasing activities of citizens and the general public.

Serious Problems in Implementing Policy Responses

A combination of actions aimed at mitigating technological risk and the prevention of emergencies, the swifter and more effective liquidation of the consequences of large scale accidents as illustrated by the case of the nuclear power industry, show an intention to introduce new management approaches to promote safe and sound economic development. These approaches are distinguished by a deep attempt to peruse a more and comprehensive understanding of the overall problem, beginning with the causes of accidents and finishing with their consequences.

However, from our perspective, the policy responses taken with respect to major accidents in industry and transport should by no means be considered fully adequate to requirements produced by a system approach to technological risk management. We will illustrate again from the nuclear power development area.

As early as in 1988, government officials from Byelorussia and the Ukraine expressed their unanimous opinion that a large-scale state program for the elimination of the Chernobyl disaster consequences should be elaborated. This program was approved only at the end of 1989; it mostly dealt both with deactivation and resettlement activities and paid little attention to the socio-economic growth of areas outside of the 30 kilometer zone where newcomers from the Chernobyl area are residing.

It should also be noted that suspending NPP construction in Krasnodar as well as Ignalinskaya, and stopping the NPP in Metzamor in Armenia along with other restrictions leads to a lowering of the overall capacity of power plants by 31 million kilowatts. This loss can be compensated for only by constructing coal power plants, considering the weak willingness of the federal government to introduce from energy saving approaches. The extensive type of economic growth being contemplated nowadays will lead to an increase in power consumption and will increase the problem of solving the energy supply question. Thus, a shift to an energy conservation strategy is of great importance, but not only from an energy supply point of view but in terms of risk as well.

Our personal view is that sufficient attention has not been paid to ergonomics aspects of safety. However, as illustrated by the Chernobyl disaster, many human errors are involved in shortcomings in human-machine interface. This includes ignorance or not paying adequate attention to particulars of human psychology and physiology that affect the use of machine devices. According to K. V. Frolov, Vice President of the USSR Academy of Sciences, only eight percent of Soviet technology meets modern requirements on safety and ergonomics (Izvestia, 1988). No less real are problems of dealing with control and measuring devices that are needed for initial screening and assessment of technology, technological processes, management, etc., as well as those that concern modern equipment for civil defense units which should support activities performed by local emergency commissions.

Last but not least is the issue connected with the development and the reliability of the functioning of warning and communication systems which provide multichannel and timely information flows to different users including different segments of the public. I argue that by now the information systems at the disposal of relevant Soviet services and organizations do not satisfy the requirements of a continuous and inclusive mechanism for reaching all levels of management as well as the public.

There is also the problem of risk communication, especially in terms of correct interpretation of available data. For example, it is not rare to find that different means and channels of communication can provide contradictory information causing tension and confusion both among officials and communities. This phenomena was observed in particular during the postimpact phase of the Chernobyl accident as well as other emergencies.

A system approach to management of sophisticated technological units that are hazardous to humans assumes having monitoring and auditing systems that cover the whole life cycle of these units from the "cradle to the grave". This kind of approach facilitates overcoming the difficulties discussed above although it will not eliminate them completely. Technological and environmental impact assessments of the projects performed by independent (from the ministries or departments involved) experts, along with initial involvement by the concerned elements of the public, would make the decision making process easier.

References

Argumenty i Facty, No. 16, 1988, p. 8.

Diagnoz Poslye Chernobylia, Sovetskaya Rossiya. December 30, 1988, p. 3.

Gale, R. Tochka Vo Vjellemai. Pravda, April 1, 1988, p. 3.

Izvestia, September 4, 1988, p.3.

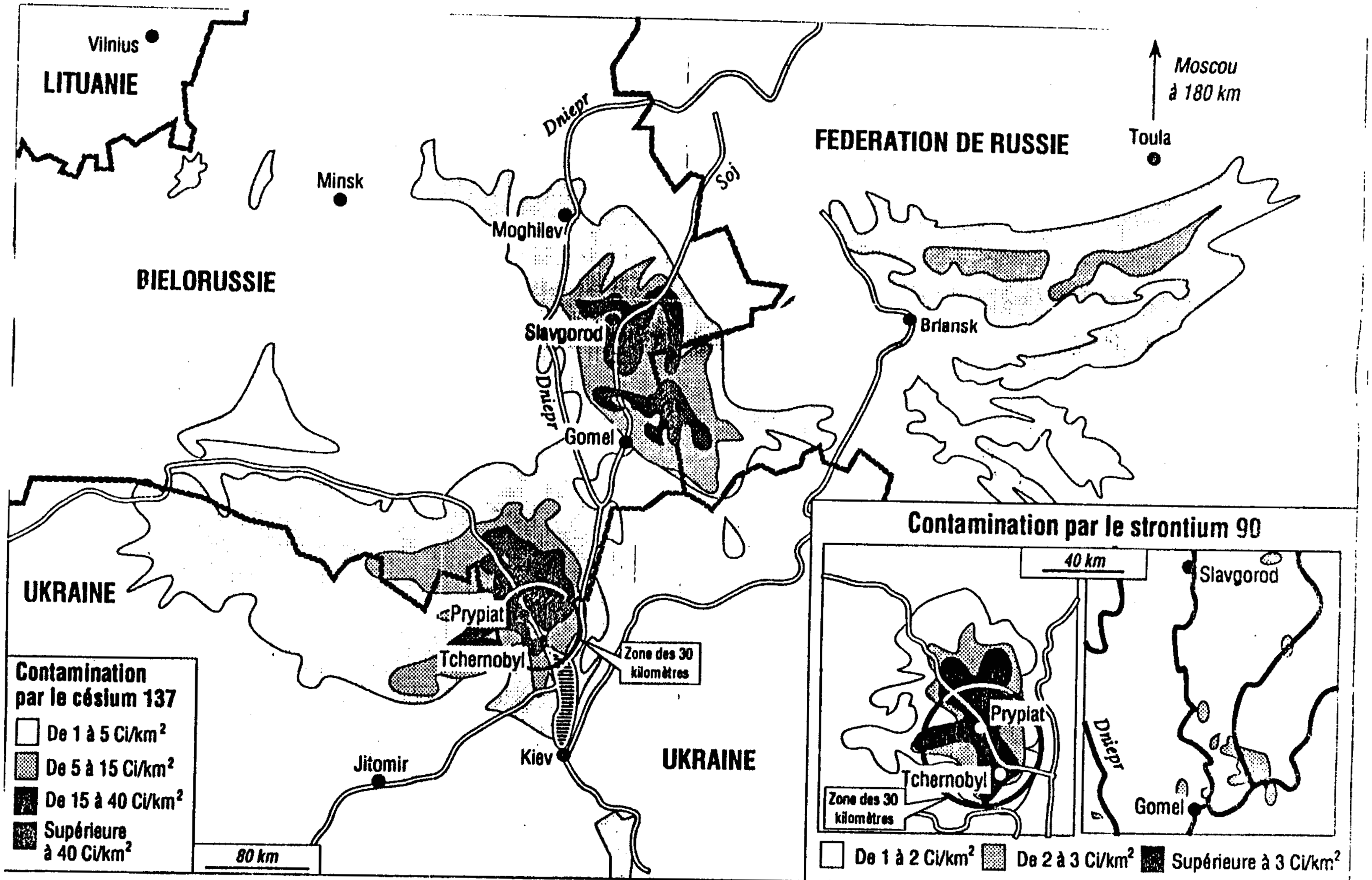
Porfiriev, Boris. Les victimes principles, les enfantes. La Croix, No. 32881, April 26, 1991, p. 4.

Porfiriev, Boris. Kommentari k. statie yu. Koriankina. "Vo chto oboshelsya chernobyl?" Poahrnoye Delo. 1991. No. 4, pp. 14-16.

Pravda, March 19, 1989, p.2.

Sostoyanive Prirodnoi Sredi i Prirodoochrannaya Politika, Moscow: Goskompriroda SSSR, 1990.

State of the World. Washington, D.C.: 1987.



DES ZONES TRÈS CONTAMINÉES À 200 KM DU RÉACTEUR

Ces cartes ont été publiées en septembre 1990 par le journal soviétique *Naouka i Jizn (Science et vie* en russe). Elles montrent que des zones situées à 200 km du réacteur ont des niveaux de contamination en césium 137 comparables à ceux enregistrés dans la zone interdite. Mais à la différence des habitants de ce périmètre de sécurité d'un rayon de 30 km autour de Tchernobyl, les populations de ces régions vivent depuis le 26 avril 1986 dans un environnement hautement radioactif. Et très souvent, ils ne l'ont appris que des années après... La Biélorussie est la République la plus touchée devant l'Ukraine et la Russie. Mais Toula, au nord-est de la carte n'est qu'à 180 km de Moscou... Enfin le strontium 90, encore plus toxique que le césium, est allé beaucoup plus loin que les experts l'avaient prévu. On en retrouve dans la région de Gomel, à 150 km de Tchernobyl. ***(Infographie Alexandre Darmon.)***

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