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The Price of Chernobyl: 200 Billion
(Translated from Russian)

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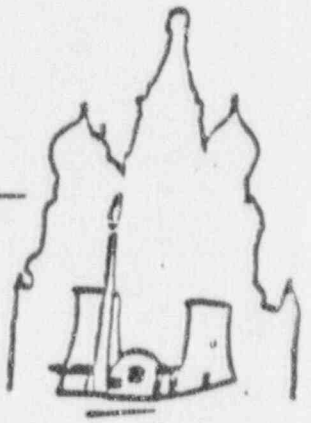

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A cost estimate is made of the consequences of the Chernobyl Nuclear Power Plant accident. The estimate includes loss of land, elimination of consequences of the accident, losses from halted operation and construction of nuclear power plant and losses of electricity. It is estimated that direct expenditures from 1986 through the year 2000 will be a maximum of 45 billion rubles. A comparison is made with Three Mile Island, where not a single reactor was removed from operation. In contrast, at Chernobyl, large productive forces were removed from operation for years.

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THE PRICE OF CHERNOBYL

Doctor of Technical Sciences Yu. I. Koryakin

200 Billion

From the official sources we know only one number, although it /3* somehow characterizes the losses from the accident at the Chernobyl nuclear power plant (AES). This is 8.591 billion rubles. Only an inveterate optimist could believe it.

For comparison we will state that according to the data of the American specialists, the damage from the accident at the Three Mile Island AES which is incomparable in scales was $130 billion. The author of the article published here has attempted to assess the losses from the Chernobyl catastrophe in the period up to the year 2000.

Damage from Loss of Land

Considering that it was necessary to remove the people from regions where it is impossible to live and work without restrictions, one can isolate two groups of territories: with contamination over 15 curie/km^2 and with contamination of 5 - 15 curie/km^2.

Today it is already obvious that resettlement from territories of the first group is necessary. In this case the total area of land completely removed from circulation will be 10,500 km^2.

The situation is more complicated for territories of the second group whose area is about 21,000 km^2. It is believed that after work for decontamination and land reclamation within a certain time some of it could be returned, if only for limited use. The question arises: which part?

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*Numbers in margin indicate pagination in original foreign text.

Obviously the assessment will be very approximate. Making a number of assumptions one can thus assume that contamination of 5 - 10 curie/km² covers 14,500 km², and this land has lost its value by 25%. The land where contamination of 10 - 15 curie/km² covers about 6,500 km², and this land has lost its value by 75%.

We consider how much the land lost from use costs? Development of 1 ha of new land withdrawn from use in this region is assessed at 20,000 - 100,000 rubles. For reliability of the calculations we take a lower cost, 30,000 rubles. Then economic losses will be:
maximum: 10^3 (10.5 + 21) thousand ha x 30,000 rubles/ha = 94 billion rubles.
minimum: 10^3 [10,500 ha x 30,000 rubles/ha + 14,000 ha x (30 x 0.25) thousand rubles/ha + 6,500 ha x (30 x 0.75) thousand rubles/ha] = 57.5 billion rubles.

And for what period has the contaminated land been removed from agricultural use? It depends on the density of contamination, the intensity of atmospheric and climate factors, biocenosis of the contaminated territories, quality and intensity of the land reclamation work.

Some agrarian experts suggest raising meat livestock on the contaminated land. For this special meat species of cattle must be raised by the watch method, and before killing for 3 - 4 months they have to be fed only "pure" feed.

I think this is completely unreal up to the year 2000.

There is also suggestion to plant the contaminated land with a forest of commercial species, but lumber will only be obtained within 40 - 50 years which is beyond the limit of the calculated turn for determining damage under discussion.

Direct Expenditures for Eliminating the Consequences of the Accident

These primarily include 8.5 billion rubles spent in 1986 for construction of the sarcophagus, settlement of the residents, construction of new housing and the corresponding infrastructure, decontamination and road building work, upkeep of the people and so forth. Publications about the expenditures made after 1986 are contradictory. As of November 1989 they were assessed at approximately 10 billion /4 rubles.

Recently the Supreme Soviets of Belorussia, the Ukraine and the RSFSR confirmed a program for eliminating consequences of the accident for a total sum of 35 billion rubles. Considering that this work is being financed from the union budget, we make an assumption that the republic agencies are prone to exaggerate the need for financing. We will assume this exaggeration to be 40 - 50%. This will yield a minimum estimate of approximately 20 billion rubles. Thus, considering the expenditures already made of 10 billion rubles, the estimate for the direct expenditures made and upcoming to eliminate the consequences of the accident from 1986 through the year 2000 will be:

maximum: 10 + 35 = 45 billion rubles.
minimum: 10 + 20 = 30 billion rubles.

We note that these numbers do not take into consideration the losses related to removal from productive labor of hundreds of thousands of people who were in the zone of the accident and in the zones of radioactive contamination.

Losses of Capital Investments Caused by Removal from Operation and Cessation of Construction of Nuclear Power Units

As a reaction to the Chernobyl catastrophe, some AES power units were removed from operation and construction of others was stopped (frozen).

The damage here can be interpreted as irreversible capital investments, those made in vain or already interrupted for some period with subsequent possible return. There are a total of 18 of these power units. The cost of building one fluctuates from 400 to 500 rubles/kW. The total sum of these "lost" capital investments is estimated at 500 rubles (including the fabricated but not installed equipment).

Losses caused by stopping of supply of electricity, its nonproduction and change in economic indicators of its production at the active NPP.

a) stopping supply of electricity.

The total unsupplied electricity by the three units of the Chernobyl NPP during their shutdown for decontamination and the necessary regulation and prestart-up operations is estimated at 20 billion kW x h. In addition the existence of the fourth block of this NPP ceased. The damage from the unsupplied electricity by this power unit we will consider to be 6 years, bearing in mind that during this time new replacement equivalent nonatomic power could be introduced. The economy during this period will not receive 42 billion kW x h.

The calculated nonproduced electricity from the Chernobyl NPP caused by the accident at the fourth power unit will thus be 20 + 42 = 62 billion kW x h.

Shutdown of the Armenian NPP to a great measure is a consequence of the Chernobyl catastrophe as a result of which the country will not receive another 40 billion kW x h.

The sum of unproduced electricity from the Chernobyl and Armenian AES will be 102 billion kW x h.

Analysis demonstrates that per unit of cost of lost electricity there needs to be an increment of 20 units of national income. The most significant damage from a shortage of electricity (or interruptions in its supply) occurs at the sectors which use relatively little electricity (machine construction, light, food and other reprocessing sectors). Electricity from the Chernobyl and Armenian AES was distributed by economic zones precisely with this infrastructure.

Based on what has been said, economic damage from these two NPP, with regard for the averaged cost of the electricity supplied by them is about 1.5 kop/kW x h and will be: 100×10^9 kW x h x 1.5×10^{-2} rubles/kW x h x 20 = 30 billion rubles.

b) unproduced electricity.

This is electricity which should have been obtained from the power units whose construction was halted, and also from those which were excluded from construction plans.

As asserted by M. A. Styrikovich and A. A. Beschinskiy, "delay only by 1 year of introduction of electricity needed by the national economy of 1 million kW leads to a loss of national income of up to 2 billion rubles".[1]

We will take into consideration only the power units of the NPP and the AST whose construction actually was started but was stopped or frozen, and consider that two power units of the nuclear central /5
heating and power plant with VVER-1000 reactors have electrical power of 1 million kW. We also stipulate that nuclear power units which are at the initial stage of construction and also losses of heat

[1] Styrikovich, M. A.; Beschinskiy, A. A. Sovremennyye problemy energetiki [Modern Energy Problems], Energoatomizdat, 1984.

generation are not taken into consideration.

In this case the total electrical nuclear power whose introduction was delayed because of halting of construction or actual freezing of financing is no less than 12 million kW. We adopt in the calculation delay of start-up for only 3 years, assuming that during this period either society will be successfully "prevailed upon" (which is almost unreal), or a replacement equivalent power on organic (gas) fuel will introduced. Finally, we arrive at yet another assumption. We will consider that the national income loses half as much as indicated by N. A. Strikovich and A. A. Beschinskiy, that is 1 million rubles for each delayed start-up of 1 million kW. This also yields a solid understatement of the damage from delayed start-up of the generating facilities.

In this case the damage will be 36 billion rubles.

One could argue that the halted supply of electricity is compensated for by the reserve of energy systems, while the nongeneration of electricity was compensated for by introduction of new replacement power facilities.

But here is the opinion of the specialists of the USSR Unified Energy System: "The situation with energy supply to the Transcaucasus, Northern Caucasus, Ukraine and Moldavia is nowhere worse. The shortage in these regions and for the country as a whole is increasing. In the Northern Caucasus in the last 10 years not a single major power facility has been introduced while the industrial and agricultural production has simultaneously grown. And because of the removal from operation of the Armenian AES power generation in the Transcaucasus has diminished by 15%. Therefore we have been forced to introduce various consumption restrictions there. The situation in the Ukraine remains complicated: rise in demand for power is 1 - 2 billion kW per year."[2]

[2]"Without Payment and Work," Izvestiya, 23 November 1989.

"The Zestafonskiy plant of ferroalloys has been completely shut down, supply of electricity to the Kutaisskiy automobile plant has been reduced by 50%, as well as to the production associations Gruzugol', Chiatur-Marganets, Khimvolokno, Azot and some others. Supply of electricity has been limited to more than 500 enterprises."[3]

Thus the assumptions that have been made not only are substantiated, but also underestimate significantly the losses from the accident.

c) change in economic indicators for energy production at the NPP.

This mainly concerns power units with RBMK reactors in which measures to increase safety are related to improvement in the neutron-physical characteristics of the core. For this the RBMK reactors have been switched to elevated initial enrichment of the uranium (2.4%) which is more expensive than before (1.8 and 2%) and leads to an increase in the net cost of electricity on the average of approximately 6%. Considering the initial expenditures related to improving reactor control leading to an increase in safety, the total increase in net cost of electricity from the power units with RBMK by the year 2000 will be 10 - 12%. Adopting the mean increase in net cost for 10 years (1991 through 2000) as 9% (0.08 kop./kW x h) with total annual generation of electricity of 14 power units with RBMK an average of 105 billion kW x h, we obtain a loss of 0.85 billion rubles.

The total losses in this group thus are:
30 + 36 + 0.85 = 66.85 billion rubles.

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[3]"Georgia: Difficulties with Electricity Supply," Izvestiya, 9 February, 1990.

Additional Expenditures for Increasing Safety of Building Structures and Equipment of the Active Power Units

This includes possible additional expenditures, and not inevitable ones. We are mainly speaking about reactor buildings, 16 active power units with RBMK reactors, as well as those six which could be started up and built before the year 2000. There are a total of 22 power units.

This means reinforcing the steam generator supports and mezzanines, roofs of the reactor buildings and so forth. There are as yet no projects of similar reconstruction, and the possibility of implementing these additional projects is under question.

The particularly approximate expenditures for additinal work could be assessed at 200 million rubles per power unit. On the whole they could be: maximum (22 power units): 0.2 x 22 = 4.4 billion rubles, minimum (16 power units): 0.2 x 16 = 3.2 billion rubles. /6

Similar work to reconstruct power units with certain VVER-440 reactors is assessed at 0.7 billion rubles.

The total expenditures are thus evaluated as:
maximum: 4.4 + 0.7 = 5.1 billion rubles.
minimum: 3.2 + 0.7 = 3.9 billion rubles.

Other Expenditures

This includes expenditures for scientific, research, design work to eliminate the consequences of the Chernobyl catastrophe, acquisition abroad of the latest computer equipment, construction of training devices, creation of the test stand-experimental base, and expenditures for various organizational measures. There has been a sharp increase in the number of international measures and visits of delegations on questions of NPP safety, expenditures have appeared

for creation and functioning of national and regional centers of public information on propaganda of AES and their publishing and advertising activity. Up to the year 2000 these expenditures are estimated as a total of 600 million rubles.

Some results.

The total damage will thus be approximately 170 - 215 billion rubles.

Taking into consideration a number of assumptions made intentionally in the calculations that significantly underestimate the size of the damage, one can assert that the probability of reaching the upper value is undoubtedly greater than the lower.

It is consequently impossible not to stress that colleagues from the Counsel of Ministers who prepared a certificate that as of November 1989 the Chernobyl catastrophe cost our country 10 billion dollars made a gross error.

According to the scale of negative impact on the national economy, the Chernobyl accident led to immeasurably greater losses than the strike of miners or the blockade of Armenia.

One can thus assert with sufficient grounds that the Chernobyl catastrophe is one of the serious factors in deterioration of the economic situation in the country. The value of this fact as a socio-economic cataclysm which was the largest in history that occurred in peace time has not yet been realized.

Comparison with the Accident at the Three Mile Island AES

These two accidents differ in their consequences as the sky from the Earth. Whereas the main difficulty in the Chernobyl

catastrophe was actual losses, removal for years of large productive forces, at Three Mile Island this was mainly losses as it were from overinsurance, for not a single reactor or power unit was removed from operation (except the damaged one) and construction was not halted. The question arises: where did such enormous numbers for damage "run together", 130 billion dollars? It consists of three types of additional expenditures: cost of building AES, cost of operating and maintenance, cost of nuclear fuel. In addition, a significant percentage of the losses is related to violation of the supply schedules and undersupply of electricity from AES. Increase in the cost of construction to a great measure is explained by the features of financing construction in the United States, and namely the percentage for capital which increases significantly with an increase in the periods of construction.

All of these organizational and operational miscalculations and violations caused by the accident in the formed system of capital functioning, in a strict monetary calculation of the interests of each partner automatically will lead to monetary deficits and additional expenditures for the final product, the AES and its operation. In sum, this all ended as 130 billion dollars.

Of course we also have similar interdependences. However with the command-administrative system that has put down deep roots in nuclear power engineering, with the universal irresponsibility inherent to this system generated by the lack of economic interest and a truly interested customer, losses as it were are dissolved in time and space.

No matter how surprising it seems, in our country there has not been a single specific organization or department which would have economically suffered from the loss of agricultural lands and about 30 million kW of electricity. One can only hope that as a result of reforms this abnormal situation will change.

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