The Role of the G-7 in Shutting Down Dangerous Soviet-Designed Reactors

by

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The Role of the G7 and International Financial Institutions

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The Moscow Nuclear Safety Summit

At the official press conference closing the Nuclear Safety Summit, held in Moscow in April of this year, G-7 Chair Jacques Chirac said that criticism of Soviet-designed nuclear reactors had been levied "four, five years ago… but today, nobody says such things because it is absurd."

In true Orwellian fashion, the tenth anniversary of the Chernobyl tragedy did not mark the beginning of the end for its chief perpetrator, the Russian Ministry of Atomic Energy, or Minatom, but rather its apparent embrace by Western governments as a full partner with their nuclear industries. The leaders of Russia and the G-7 nations achieved no breakthroughs at the Summit for reactor safety: no new agreements were signed and no new commitments for financial assistance were made.

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The "Big-8" failed to seize this opportunity to reduce nuclear dangers, and the lack of action at the Summit may even serve to increase the risk of nuclear accidents over time. Concern over President Yeltsin's reelection chances muted the G-7's earlier criticisms of nuclear safety in the FSU. The big winner emerging from the Summit was Russia's Ministry of Atomic Energy, which used the event to rehabilitate itself internationally and promote Russia's nuclear industry.

Inherent Flaws in Soviet-Designed Reactors

[Overhead 2]
The Soviet Union and its Eastern Bloc allies relied almost entirely on Soviet-designed reactors for their nuclear energy. Soviet-designed reactors still operate in ten countries throughout Eastern Europe and the former Soviet Union. There are presently 68 such reactors in operation, and 23 in various stages of construction, including reactors in Cuba and Iran.

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With the exception of four small, older graphite-moderated water-cooled reactors and two liquid metal fast breeder reactors (LMFBRs), operating Soviet-designed power reactors fall into two main reactor types: 15 graphite-moderated water-cooled RBMK reactors, and 47 pressurized water-moderated and cooled VVER reactors (27 VVER-440's and 20 later-model VVER-1000 reactors).

[Overhead 4]
The safe operation of a nuclear power reactor requires a combination of good design, good construction, good operators, and good maintenance, and I would add good regulatory oversight to ensure that these requirements are met. With the possible exception of the two Finnish reactors, none of the Soviet-designed reactors share all of these qualities. By and large the remaining 66 operating Soviet-designed reactors suffer

from poor design, poor construction, poor maintenance, poor operator training, and poor regulatory oversight. With regard to the last, many safety issues are not covered by regulatory requirements. Regulators lack manpower and other resources. Only 11 persons, for example, regulate all RBMKs. Many regulatory organizations still lack the capacity to enforce improvements in safety.

Thus, none of these 66 would be licensable in the West, and none qualify as being labeled "safe," or "safe enough." Moreover, 26 of the 66 have serious uncorrectable design flaws. These are the RBMK, or Chernobyl-type, reactors and the VVER-440 Model 230 reactors, the older first generation VVER-440 reactors.

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The RBMK, or Chernobyl-type, reactors all have the following design flaws:

- The RBMK has a fundamental design flaw, known as the "positive void coefficient," which makes operation unstable at low power or in the event of coolant loss unstable. This instability can result in a runaway power surge like the one that caused the violent explosion at Chernobyl Unit 4 in 1986. This design flaw may be partially correctable with "post-Chernobyl" technical measures, but a recent document from the G-7's Nuclear Safety Account reports that even if these technical measures are implemented, there remain, quote "residual concerns under certain conditions such as low power operation or CPS coolant system LOCA." (Nuclear Safety Account, Chornobyl Nuclear Safety Project, 7 September 1995.)

- This reactor design also uses a graphite moderator, which can burn. (The moderator is used to slow down, or "moderate" the speed of, the neutrons to facilitate the nuclear chain reaction.)

- The RBMK lacks an adequate emergency core cooling system to prevent overheating that could lead to a meltdown.

- It also does not possess Western-style secondary containment that would prevent the release of radioactivity in the event of an accident.

The U.S. Department of Energy has noted with respect to the Ignalina RBMK:[1]

> A special concern is the threat of overpressurizing the reactor cavity, leading to the upward ejection of the upper-head shield assembly, breaking the reactor seal, severing the fuel channels, and disabling the control rod function. This nuclear engineer's nightmare is possible since the reactor cavity has the capacity to withstand the steam pressure buildup of only

[1] Pacific Northwest Laboratory (Prepared for the Department of Energy, Office of Energy Intelligence NN-3), *Most Dangerous Reactors*, May, 1995.

two fuel channel ruptures---an exceptionally small fraction of the existing 1661 channels.

This is all the more troubling given that RBMKs have already experienced single channel failure due to overheating and melting of the fuel, and there are no good computer analyses which indicates what the margin of safety is with respect to propagation of channel failure.

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The VVER-440 Model 230 is a more forgiving reactor compared to the RBMK. The low power density, large volume of water in the core, and the six coolant loops gives the operators a longer time to respond to accident conditions. There have been several cases where VVER-440s have lost electrical power to the core cooling system, but operated for several hours with no additional cooling. Despite these advantages, the VVER-440/230 suffers from inherent design flaws:

- The VVER-440/230 lacks an adequate emergency core-cooling system.
- It also does not possess Western-style secondary containment that would prevent a widespread release of radioactivity in the event of an accident.

In addition to these flaws which cannot be "fixed" with technical upgrades, there are other serious safety concerns with both reactor types which can be improved with costly upgrades. These problems include:

- inadequate in-core instrumentation
- unreliable safety valves
- unreliable instrumentation and control systems
- insufficient diversity of shutdown systems
- inadequate fire protection
- poor redundancy and shortcomings in emergency power supply

The VVER-440 Model 230s are particularly susceptible to common-mode failures resulting from a single fault such as a fire or pipe rupture—events that occasionally occur at any power plant. The emergency core cooling system is dangerously undersized and would be ineffective for all but minor pipe breaks.[2]

In 1990, following the unification of East and West Germany, the new unified German government shut down four VVER-440 Model 230 reactors (Nord 1-4) and one Model 213 (Nord 5) that had been operating in East Germany, and canceled the construction of three additional Model 230s (Nord 5-8).

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[2] Ibid.

As evidenced by the German action, there are serious safety concerns with the later-model VVER-440/213 (and the VVER-1000 as well), such as insufficient fire protection and instrumentation and control systems.

The Finns corrected the design problems of the two VVER-440 Model 213 constructed at Loviisa by installing a Western control system designed by Siemans, a German firm, by installing an American-style secondary containment, and by replacing the safety valves. These two reactors began operating in 1977 and 1980, respectively.

But adding secondary containment and emergency core cooling systems to either the RBMK or the VVER-440/230 after construction has been completed would be financially prohibitive, and, according to many nuclear engineers, technically infeasible. The only way to make these reactors acceptably safe is to shut them down -- all 26 of them.

Russia and the West have failed to take the necessary concrete steps to promptly shut down these most dangerous reactors despite their inherent design flaws. This is as true now as it was at the time of the Chernobyl accident. Instead, most of the international nuclear-safety assistance toward Soviet-designed reactors since Chernobyl has been devoted to operator training and short-term technical upgrades. While better than nothing, these measures are still akin to putting a Band-Aid over a compound fracture.

Western Safety Assistance Programs Since 1992

During the decade since Chernobyl, considerable attention has been paid to the dangers of Soviet-designed nuclear power in Eastern Europe and the FSU.

The 1992 Munich G-7 Summit called for a program of action to improve nuclear safety in the region. This "program" resulted in an analysis jointly undertaken by the European Bank for Reconstruction and Development (EBRD), the International Energy Agency (IEA) and the World Bank. This study found that:

- It would have been technically feasible to replace all the "high risk" plants--RBMKs and VVER-440/230s--by the mid-1990s, by replacing the output of these plants with alternative supplies.

- The "low nuclear" scenario, which involved the most rapid phase out of the most dangerous reactors, also was predicted to require the lowest investment cost - approximately $18 billion between 1993 and 2000, whereas the "medium" and "high nuclear" scenarios, which involved upgrading existing reactors and completing new facilities, would have cost in the neighborhood of $24 and $25 billion respectively.

The conclusions of this report were also likely on the conservative side, since it did not look at potential savings with the implementation of energy efficiency measures or power sector restructuring, but only new electricity supply options.

Although this joint study was to serve as the basis for the G-7's nuclear safety program, instead of a coordinated effort to replace dangerous reactors, the G-7 has undertaken over the last four years programs to fix the "fixable" safety design flaws. The three principal sources of funding are: (a) the EBRD/Nuclear Safety Account; (b) two safety assistance programs of the European Union (EU), namely, Phare which provides assistance to Central and Eastern European Countries (CEEC), and Tacis which provides funding for the New Independent States; and (c) the U.S. Department of Energy. The following commitments from these sources have been made to Soviet-designed reactor safety programs since 1990:

EBRD/Nuclear Safety Account contribution agreements, May 1996:	205	MECU[3]
EU nuclear safety programs, 1990-1995:		
Phare	132	MECU
Tacis	423	MECU
Total EU	512	MECU
US DOE International Nuclear Safety Program, 1995-1996:	90.4	M$ US

Less than half of these funds have been expended. Moreover, this assistance amounts to very little, particularly on a per reactor basis, and it covers a wide spectrum of safety and safety related issues, primarily those related to the training of reactor operators and other plant personnel, fire and earthquake protection, regulatory assistance, improvements in instrumentation and control systems, nuclear event response procedures, waste management and Chernobyl remedial activities. Have these safety programs since Chernobyl resulted in any significant decrease in the likelihood of a large-scale nuclear accident? Clearly not. Here's also is what G-7 safety agencies have to say:

- US DOE (Most Dangerous Reactors, May 1995): "Many Soviet-designed reactors operating in the successor states of the Soviet Union pose significant safety risks because of inherent design deficiencies, deteriorating economies, political turmoil and weak regulatory oversight. As a class, these reactors continue to experience serious incidents, raising the specter of another accident akin to Chernobyl."

- Joint communique from French and German nuclear safety agencies (March 1996): "Improvements carried out in recent years on Soviet-designed plants have reduced the risk of an accident such as occurred on April 26, 1986, but there is still too great a risk of a serious accident."

[3] One $ U.S. = 5.2 FrFranc = 0.81 European Currency Unit (ECU); June 21, 1996.

Potential for Efficiency and Power Sector Restructuring

In some cases, modest improvements in energy efficiency and power sector restructuring alone could make up for the output of dangerous plants.

- Only 5% of Ukraine's power is produced by Chernobyl, and only about 6% of Russia's electricity is generated by its most unsafe plants.

- Electricity consumption fell 25% in Ukraine and 20% in Russia between 1990-1994. This decrease in Ukraine alone equaled approximately seven times Chernobyl's 1994 output.

- An analysis by Battelle Laboratories, performed for the US DOE, identified energy savings though low-cost measures that could replace more than one-and-a-half Chernobyls. In Russia, energy savings could replace the equivalent of twice the electricity produced by its most dangerous reactors.

- The potential for energy efficiency gains in the countries operating the most dangerous nuclear reactors is truly enormous. Most estimates demonstrate that energy use in Eastern Europe and the former Soviet Union could be reduced by 30-50% or more with equipment and practices currently being used in Western Europe, such as: efficient lighting, appliances, and motors; proper insulation; and improved energy accounting and management.

- Renewable energy sources and natural gas also show great promise for countries operating dangerous plants. For example, there is great potential for wind and biomass power in Lithuania, Kola Peninsula of Russia, and Crimea in Ukraine, where dangerous plants now operate.

The Role of International Financing Institutions

The G-7 needs to encourage international financial institutions to capitalize on the advantages of large scale energy saving projects in the region of Eastern Europe and the former Soviet Union instead of investing in unnecessary and environmentally dangerous supply-side projects. While the banks -- World Bank and the European Bank for Reconstruction and Development (EBRD) in particular -- have begun funding such projects, the transition has been much too slow.

For example, we have seen the G-7 this year pressure the EBRD to finance the completion of two new VVER-1000's - later model Soviet-designed reactors - for Ukraine in return for Chernobyl shutdown. The G-7 has agreed with Ukraine on a framework for Chernobyl shutdown by 2000 in return for Western funds (now estimated at $3.1 billion), but the break-down of the funding is, as yet, uncertain. Early this year Jacques Chirac wrote the following to the presidents of the World Bank and EBRD:

> "regarding the completion of two nuclear reactors according to internationally accepted safety standards, we expect the EBRD's active engagement in securing their financing together with the European Investment Bank (Euratom) loans."

This letter, which amounts to essentially a mandate to the Bank to complete nuclear reactors in Ukraine, was written before the completion of any credible least-cost work on which to base the Bank's funding decisions. The Bank has yet to complete any such least-cost work for Ukraine, and has not even begun engineering assessments of the partially completed reactors to determine the cost of their completion. Even so, the Bank continues to feel extreme pressure to finance construction of these potentially dangerous reactors by the end of the year, to the tune of an estimated $1 billion.

International Expert Task Force Proposal to the G-7

Prior to the Summit, NRDC and the Center for Russian Environmental Policy organized an International Expert Task Force. This task force was made up of more than 40 distinguished nuclear and energy experts to develop policy recommendations to the G-7 leaders and Russia in the areas of nuclear safety, nuclear democracy, sustainable energy development, and nuclear weapons reductions and security of weapon-usable materials. On nuclear safety, our task force urged Russia and the G-7 to:

(1) Identify, on an urgent basis, the fifty most hazardous nuclear reactors worldwide for priority shutdown within ten years, including all Soviet-designed RBMK and VVER-440/230 reactors.

(2) Provide sufficient capital and technical assistance for replacement-power development and for the permanent and safe decommissioning of the reactors identified for priority shutdown, particularly in countries operating RBMK and VVER-440/230 reactors.

We proposed to the G-7 that they create a $10 billion Sustainable Energy Revolving Fund, or SERFUND, that would finance alternative energy projects such as energy efficiency measures, renewable energy, natural gas, and conventional power supply improvements to replace dangerous plants. This fund could be administered by an international financing institution, just as the Nuclear Safety Account is administered by the EBRD, but instead of going towards short-term and inadequate upgrades, it would fund real, long-term solutions to the region's energy problems.

But, as noted above, no such concrete actions were taken at the Nuclear Safety Summit.

Conclusions

In sum, with the possible exception of the two Finnish reactors, none of the 68 operational Soviet-designed reactor can be considered adequately safe. Twenty-six of these, 15 RBMKs and 11 VVER-440 Model 230 reactors, lack adequate emergency core cooling systems and secondary containment systems, and should be shut down immediately. The seven richest industrialized nations in the world refuse to provide adequate leadership or funding assistance to shut down these reactors. To the contrary, they have provided minimal assistance that will likely prolong the lives of these dangerous reactors. Moreover, some of the safety assistance efforts appear to be designed primarily as opportunities to divert funding from international lending institutions to financially-strapped nuclear industries in the G-7 member states, and only secondarily as efforts to improve the quality of life in the recipient countries.

OVERHEAD 1

G-7 Communiques on Nuclear Safety

Germany, 1992

"the safety of Soviet designed nuclear power plants gives cause for great concern... The new States concerned in the former Soviet Union and the countries of Central and Eastern Europe must give high priority to eliminating this danger... A special effort should be made to improve the safety of these plants. We offer the states concerned our support."

Japan, 1993

"We welcome the progress made in the nuclear safety programme agreed at the Munich Summit... We invite the World Bank, together with the IEA, to continue the dialogue with each of the countries concerned, and working with other lending institutions including the EBRD and the EIB, to support them in developing longer term energy strategies. Our aim is to agree as quickly as possible on a framework for coordinated action by all those involved following a country by country approach. We will review the progress made in 1994."

Italy, 1994

"We welcome the progress made in the nuclear safety programme, agreed by the Munich and Tokyo Summits, concerning [nuclear safety in] the countries of Central and Eastern Europe and the former Soviet Union... We remain committed to the existing international initiatives to promote an early closure of high risk reactors. The closing down of the Chernobyl nuclear power plant is an urgent priority."

Canada, 1995

"We welcome the progress to date in improving the levels of nuclear safety in the countries of Central and Eastern Europe and the Newly Independent States. We congratulate President Kuchma of Ukraine on his decision to close the Chernobyl nuclear power plant by the year 2000."

Moscow, 1996

"We are committed to give an absolute priority to safety in the use of nuclear energy. As we approach the tenth anniversary of the Chernobyl accident, it is our shared objective that such a catastrophe cannot reoccur."

OVERHEAD 2

COUNTRIES OPERATING OR CONSTRUCTING SOVIET DESIGNED REACTORS

	Operating	Under Construction
Russia	29	8
Ukraine	15	4
Bulgaria	6	0
Slovak Republic	4	4
Czech Republic	4	2
Hungary	4	0
Lithuania	2	0
Finland	2	0
Armenia	1	1
Kazakhstan	1	0
Cuba	0	2
Iran	0	2
TOTAL	68	23

Soviet Built Reactors

OVERHEAD 3

Operating

Country	Pre-RBMK	RBMK	VVER-440/230	VVER-440/213	VVER-1000	BN-350	BN-600	BN-800	Total
Russia	4	11	4	2	7		1		29
Ukraine		2		2	11				15
Lithuania		2							2
Bulgaria			4		2				6
Slovak Republic			2	2					4
Hungary				4					4
Czech Republic				4					4
Finland				2					2
Armenia			1						1
Kazakhstan						1			1
Total	4	15	11	16	20	1	1	0	68

Partially Constructed

Country	Pre-RBMK	RBMK	VVER-440/230	VVER-440/213	VVER-1000	BN-350	BN-600	BN-800	Total
Russia		1			5			2	8
Ukraine					4				4
Lithuania									0
Bulgaria									0
Slovak Republic				4					4
Hungary									0
Czech Republic					2				2
Finland									0
Armenia			1						1
Kazakhstan									0
Cuba				2					2
Iran					2				2
Total	0	1	1	6	13	0	0	2	23

OVERHEAD 4

REQUIREMENTS FOR SAFE REACTOR OPERATIONS

GOOD DESIGN

GOOD CONSTRUCTION

GOOD OPERATORS

GOOD MAINTAINANCE

GOOD REGULATORY OVERSIGHT

OVERHEAD 5

RBMK DESIGN FLAWS

- Positive Void Coefficient Under Some Accident Conditions
- Graphite Moderator That Can Burn
- Inadequate Emergency Core Cooling System
- No Secondary Containment

OVERHEAD 6

VVER-440 Model 230 DESIGN FLAWS

- Lack of In-Core Instrumentation.
- The Control Room Instrumentation Is of Poor Quality.
- The Safety Valves Are Unreliable.
- No Emergency Core Cooling System.
- No Secondary Containment.

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GOOD DESIGN

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Nuclear Safety Summit
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In true Orwellian fashion, the tenth anniversary of the Chernobyl tragedy did not mark the beginning of the end for its chief perpetrator, the Russian Ministry of Atomic Energy, or Minatom, but rather its apparent embrace by Western governments as a full partner in their nuclear industries. The leaders of Russia and the G-7 nations achieved no breakthroughs at the Summit for reactor safety: no new agreements were signed and no new commitments for financial assistance were made.

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Inherent Design Flaws

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Russia and the West have failed to take the necessary concrete steps to promptly shut down these most dangerous reactors despite their inherent design flaws. This is as true now as it was at the time of the Chernobyl accident.

Despite the "unfixable" nature of many of the most serious of these safety problems, most of the international nuclear-safety assistance toward Soviet-designed reactors since Chernobyl has been devoted to short-term technical upgrades designed to improve fire protection, quality of training of plant personnel, and instrumentation and control systems. While better than nothing, these measures are still akin to putting a Band-Aid over a compound fracture.

Western safety assistance programs since 1992

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In some cases, modest improvements in energy efficiency and power sector restructuring alone could make up for the output of dangerous plants.

- Only 5% of Ukraine's power is produced by Chernobyl, and only about 6% of Russia's electricity is generated by its most unsafe plants.

- Electricity consumption fell 25% in Ukraine and 20% in Russia between 1990-1994. This decrease in Ukraine alone equaled approximately seven times Chernobyl's 1994 output.

- An analysis by Battelle Laboratories, performed for the US DOE, identified energy savings thoughlow-cost measures that could replace more than one-and-a-half Chernobyls. In Russia, energy savings could replace the equivalent of twice the electricity produced by its most dangerous reactors.

- The potential for energy efficiency gains in the countries operating the most dangerous nuclear reactors is truly enormous. Most estimates demonstrate that energy use in Eastern Europe and the former Soviet Union could be reduced by 30-50% or more with equipment and practices currently being used in Western Europe, like efficient lighting, appliances, and motors, proper insulation, and improved energy accounting and management.

- Renewable energy sources and natural gas also show great promise for countries operating dangerous plants. For example, there is great potential for wind and biomass power in Lithuania, Kola Peninsula of Russia, and Crimea in Ukraine, where dangerous plants now operate.

The Role of International Financing Institutions

The G-7 needs to encourage international financial institutions to capitalize on the proven profits of large scale energy saving projects in the region of Eastern Europe and the former Soviet Union instead of investing in potentially unnecessary and environmentally dangerous supply-side projects. While the banks - World Bank and the European Bank for Reconstruction and Development (EBRD) in particular - have begun funding more and more such projects, the transition has been much too slow.

For example, we have seen the G-7 this year pressure the EBRD to finance the completion of two new VVER-1000's - later model Soviet-designed reactors - for Ukraine in return for Chernobyl shutdown. The G-7 has agreed with Ukraine on a framework for Chernobyl shutdown by 2000 in return for Western funds (now estimated at $3.1 billion), but the break-down of the funding is, as yet, uncertain. Early this year Jacques Chirac wrote the following to the presidents of the World Bank and EBRD:

> "regarding the completion of two nuclear reactors according to internationally accepted safety standards, we expect the EBRD's active engagement in securing their financing together with the European Investment Bank (Euratom) loans."

This letter, which amounts to essentially a mandate to the Bank to complete nuclear reactors in Ukraine, was written before the completion of any credible least-cost work on which to base the Bank's funding decisions. The Bank has yet to complete any such least-cost work for Ukraine, and has not even begun engineering assessments of the partially completed reactors to determine the cost of their completion. Even so, the Bank continues to feel extreme pressure to finance construction of these potentially dangerous reactors by the end of the year, to the tune of an estimated $1 billion.

What our International Expert Task Force Proposed to the G-7

Prior to the Summit, NRDC and the Center for Russian Environmental Policy organized an International Expert Task Force. This task force was made up of more than 40 distinguished nuclear and energy experts to develop policy recommendations to the G-7 leaders and Russia in the areas of nuclear safety, nuclear democracy, sustainable energy development, and nuclear weapons reductions and security of weapon-usable materials. On nuclear safety, our task force urged Russia and the G-7 to:

(1) Identify, on an urgent basis, the fifty most hazardous nuclear reactors for priority shutdown within ten years, including all Soviet-designed RBMK and VVER-440/230 reactors.

(2) Provide sufficient capital and technical assistance for replacement-power development and for the permanent and safe decommissioning of the reactors identified for priority shutdown, particularly in countries operating RBMK and VVER-440/230 reactors.

We proposed to the G-7 that they create a $10 billion Sustainable Energy Revolving Fund, or SERFUND, that would finance alternative energy projects such as energy efficiency measures, renewable energy, natural gas, and conventional power supply improvements to replace dangerous plants. This fund could be administered by an international financing institution, just as the Nuclear Safety Account is administered by the EBRD, but instead of going towards short-term and inadequate upgrades, it would fund real, long-term solutions to the region's energy problems.

But, as noted above, no such concrete actions were taken at the nuclear safety Summit.

Conclusions