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**INTRODUCTION**

Today I'd like to discuss a wide array of nuclear safety issues in the New Independent States of the former Soviet Union and how the United States is attempting to deal with them. The Clinton Administration has taken several major steps to assist the Russian Federation and other nations that emerged from the collapsed Soviet empire; one of our highest priorities has been to confront nuclear safety concerns. Progress has been made, to be sure, but frankly much more needs to be done. Topping the list of concerns are the nuclear power reactors at Chernobyl in Ukraine.

But first, I have a story.

> A few years ago, I was visiting the two nuclear power reactors still operating at Chernobyl, in Ukraine. The sloppiness and clutter were appalling -- electrical and fire hazards everywhere. I commented on this to my host. He looked at me sadly. "Our workers," he said, "will not bend down to pick up an oil-soaked rag from the floor, even though they know that fire is the greatest of all safety risks in a nuclear plant. But if a fire breaks out, like the one here in 1986, those same workers, without a moment's hesitation, will risk their lives heroically -- even give their lives -- to fight the fire and to save their co-workers."

We in the west have learned that heroism is not a sound basis for assuring nuclear safety. Rather, what is required is the more routine establishment of a safety culture which gives the sort of attention to detail that was generally lacking in the

former Soviet Union. For no significant amounts of western capital will flow into these countries' nuclear programs until we are convinced that the infrastructure exists to bring the safety of Soviet-designed nuclear power plants up to acceptable levels or to identify alternative energy sources so that their least safe reactors can be shut down.

An essential element for safer nuclear power lies in the general economic reforms now being undertaken by nations with former Communist or state-directed economic systems. Market pricing for energy, detailed cost calculations by utility managers, attention to energy conservation as a way to reduce demand, and foreign investments in potentially profitable energy sector industries will ultimately do more to help improve nuclear safety than any likely level of western technical safety assistance.

But for all this to happen, the United States and its western colleagues believe it is essential to provide assistance at both the plant level and to the regulatory infrastructure in the New Independent States to help lay the groundwork for a new safety culture. Considerable progress has been made in the neighboring countries of Eastern Europe, especially in the Czech Republic and in Hungary, so we know progress is possible. Unfortunately, often it is at the very point that nuclear operators or managers from the New Independent States or Eastern Europe think they have accomplished their safety task because they have mitigated the most serious safety concerns that we in the West believe they have only just begun.

**SAFETY CONCERNS IN THE NEW INDEPENDENT STATES**

What are the concerns that have led the U.S. and others to seek to upgrade the safety of Soviet-designed reactors, and, ultimately, to persuade the relevant authorities that at least some of these reactors should be retired?

The various Soviet-designed reactors are the RBMK (Chernobyl-type) and VVER-440, Model 230 (an older pressurized-water-reactor) reactors which have fundamental safety flaws, and the newer VVER-440, Model 213 and VVER-1000 reactors. Safety shortcomings common to all these reactors include fire safety problems, a lack of detailed and documented quality control measures, a lack of quality spare parts and components meeting original design requirements, and only limited safety analyses of the reactors, while operating procedures and other documentation are deficient.

In addition, the RBMK and VVER-440, Model 230 safety flaws cannot be remedied and can be mitigated to only a very limited extent. Both have inadequate containment systems and ineffective

emergency core cooling provisions. Although the VVER-440, Model 230 is more forgiving as a result of its comparatively large water inventory and relatively easy to operate, if something does go seriously wrong, it lacks defense in depth.

The RBMKs are the least safe. They have no effective containment system; their emergency core cooling effectiveness is limited only to pipe breaks in certain locations; and they possess the characteristic of RBMKs that caused the catastrophic results at Chernobyl -- "positive reactivity feedback" ("positive void coefficient"). I would note that some RBMK operators have taken steps to correct this condition through increasing the enrichment of the fuel.

These RBMK's also violate some basic principles I believe are necessary for safe nuclear power plants:

(1) make them easy to operate safely, so that extraordinary situations do not arise;

(2) give them plenty of extra safety margin, to allow recovery from any challenges that do occur;

(3) give them last ditch emergency systems, to keep the nuclear core from melting and, if all else fails, to keep the radiation contained within the plant; and

(4) keep the workforce motivated and attentive to details which reflect in a clean and disciplined operating environment; carelessness leads to accidents.

The bad news is that fifteen of the Chernobyl-type power reactors are still running; two at Chernobyl, two in Lithuania, and the rest in Russia. The good news is that Russia has recently signed an agreement with the U.S. that will lead to the closure of the three Chernobyl-type plutonium production reactors in Russia at Tomsk and Krasnoyarsk. This is an extremely encouraging start, if carried out and built upon. The historic importance of this agreement is undeniable -- it furthers our two nations' goals of reducing the proliferation of nuclear weapons. But beyond this, there is reason to be optimistic that closing the least safe Soviet-designed power reactors can be linked to the development of alternate energy sources to replace electricity demand.

Beyond basic design problems, Russian and Ukrainian operators generally lack the attitude that safety is a primary objective and the responsibility of all, and effective training and procedures especially in the maintenance and operational areas. In addition, managers have never imposed systems which foster a positive attitude toward safety, because all their lives

they have been told that precedence must go to producing more electricity.

Economic and infrastructure problems also affect safety. Nuclear power plant operators have difficulty getting adequate payment for the power they supply. This interferes with required maintenance and prevents improvements from being made. Managers are often more concerned with meeting their payroll by continuing operation than with safety concerns that might warrant shutdown. Russian nuclear operators simply do not put the same weight on prevention and risk avoidance that is done in the United States, Western Europe, or Japan.

To add to their problems, the countries of the former Soviet Union do not have the western tradition of regulation. In Russia, for example, the nuclear regulatory body does not operate under national nuclear legislation such as that which set up the NRC. There is a ukase or decree, but it is not legislatively based and lacks clarity about relations to operating organizations, standard-setting, and enforcement.

One of the NRC goals is to improve both the legal and the political stature of the regulators in Russia and Ukraine -- to give them an important place at the table, so to speak -- so they command the respect of both the nuclear ministries and the utilities operating nuclear power plants. The shutdown of unsafe plants in these countries will ultimately depend upon the strength and independence of such regulators.

Despite all these serious limitations, I perceive progress in the safety consciousness in much of the NIS. There is significant progress in the condition of many of the plants and an improved sensitivity among the leaderships of these countries to the safety concerns of the West.

In addition, the U.S. and the Russian political leadership have been effectively engaged in a fruitful dialogue on nuclear safety in the context of overall economic and energy development. I have reason to hope Russia has turned the corner to a new, more productive path in which nuclear safety improvements will be taken in the context of an overall energy strategy that will emphasize market forces, reasonable energy prices, and viable alternatives to her least safe nuclear power plants. I hope that Ukraine, too, will follow a similar path in the coming months.

I can see the growth, however slowly, of potentially strong and independent regulatory bodies that may eventually be capable of exercising the same kind of authority over safe operations that the NRC does in the United States.

COUNTRY REPORTS

## RUSSIA

A major safety concern in Russia is the continued operation of the 11 Chernobyl-style RBMK's and 6 VVER 440/230 models. The safety problems run the gamut -- poor plant design (neither model has a containment), siting, construction, quality assurance, operation, maintenance and regulation. While there is broad agreement in the Western nuclear community on what needs to be done to address Russian nuclear safety issues, there is no similar consensus on the Russian side on the most urgently-needed near-term assistance measures. Although some Russian officials agree that substantial improvements are needed, Russian authorities do not accept Western judgments that the RBMKs and VVER 440/230s pose sufficient inherent risks to be promptly shut down. Instead, they argue that the large quantities of energy provided by the facilities are vitally needed.

The NRC assistance program to Gosatomnadzor is accordingly directed to improving not only its ability to regulate, but also its stature within the atomic energy establishment, and this is not an easy task.

## UKRAINE

There are 14 reactors operating in Ukraine; 2 are RBMKs at Chernobyl, 2 are the newer VVER-440s at Rivne, and the rest are VVER-1000s at four sites. Six more VVER-1000s are under construction at Zaporizhia, Khmelnytskiy, South Ukraine and Rivne. A major safety concern in Ukraine is the continued operation of the Chernobyl reactors -- which should be shut down as soon as possible.

Last October, Ukraine announced a program under which it will continue to operate Chernobyl 1 and 3 power plants until the end of the century, overturning a 1991 decision by the Parliament to shut them down by the end of 1993.

An IAEA mission has just come back from Chernobyl; it recommended to President Kravchuk that Chernobyl should not continue operations because of, among other causes, the loss of skilled personnel and the fact that they have no place to store additional spent fuel. This has become a very serious international issue that will be addressed in Vienna later this month.

It is doubtful that Chernobyl Unit 1 could operate past about 1996 or 1997 anyway, because of the high cost of renewing its pressure tubes for graphite channel reconstruction, but Unit 3 could operate until 2004, when this maintenance would have to be performed.

In 1992 the World Bank concluded that Chernobyl could be closed and demand for electricity could be met from fossil fuel sources. The Ukrainian government disagrees with the World Bank conclusions, wants to expand its nuclear power base, and hopes to finish three VVER 1000 reactors under construction, to avoid dependence on other fuels. But they have no money or resources to do this.

It is unlikely the Ukrainians can whip their economy into shape to pay for the completion of several VVER 1000s to increase their electricity generating capability without concessionary financing. The U.S. has tied a number of Russian nuclear safety and weapons dismantlement issues together in the Gore-Chernomyrdin context, and it would make sense to do the same for Ukraine.

The U.S., along with other key donors, international organizations and financial institutions needs to help Ukraine develop an energy strategy that would allow closing of Chernobyl. Such a strategy would have to include assistance in bringing three VVER 1000s on line in the next couple of years. In addition the Ukrainians need help in examining how a vigorous conservation program could help their energy demand picture.

## ARMENIA

Because of the critical need for reliable supplies of energy, the government of Armenia has decided to restart the two reactors at the Medzamor facility. Medzamor would supply over one-third of Armenia's normal electrical needs and double the currently available supply of electricity. Armenia has recently signed an agreement with Russia for assistance in technical, safety, regulatory and organizational matters. Russia has also agreed to provide new nuclear fuel and to reprocess spent fuel from the reactor.

Despite such assistance, it is unclear how these plants could be reopened. Although Armenia proposes safety improvements recommended by the IAEA to its upgraded VVER-440, Model 230, reactors, there would remain serious concerns about safety shortcomings, together with seismic and security vulnerabilities. These plants would never be licensed to operate by any Western regulatory authority. Therefore the U.S. will not provide financial assistance for a restart.

We have been frank with Armenian authorities on this score. But since there is irradiated fuel on site and because the government might restart the reactors without Western help, the United States has indicated a willingness to provide regulatory assistance to establish a competent, independent regulatory agency in Armenia.

## KAZAKHSTAN

The Kazakhstan nuclear safety program suffers from the overall economic decline since the breakup of the Soviet Union. The majority of nuclear specialists are from the European part of the former Soviet Union; many of them are now leaving Kazakhstan in part because of the low wages and because of fear that rising nationalism may permanently separate them from nuclear scientific research centers in Russia. The moratorium on nuclear weapons testing has also eliminated many scientific jobs. Consequently, whatever remains of the former Russian safety practices is now in even more serious jeopardy. And as is now common in the NIS, Kazakhstan lacks the funds to maintain its nuclear facilities properly and to clean up sites that have been contaminated.

Parts of the Semipalatinsk nuclear weapons complex which has been declared an ecological disaster zone by Kazakhstan, already resemble ghost towns and several of the nuclear facilities are falling into disrepair. In recent Almaty television news broadcasts the director and deputy director of the BN-350 fast breeder reactor have noted the loss of 70 percent of its nuclear scientists and the negative effects of the brain drain on safe operation of the reactor.

Kazakh scientists estimate that some 500,000 people living near Semipalatinsk have suffered permanent health damage. Increased immune system deficiencies such as hepatitis B, and increases in the infant mortality rate, and tuberculosis rates have been recorded. Rivers near industrial and nuclear sites are heavily contaminated with heavy metals which find their way into the drinking water supply.

Russia now refuses to accept nuclear waste from the new republics. This has prompted the growth of primitive and/or illegal radioactive waste dumps in Kazakhstan. The one approved waste burial site located near Almaty has been declared unsuitable for permanent use.

Kazakhstan's President Nursultan Nazarbayev has also called for Chinese cooperation to clean up the after-effects of nuclear blasts at China's Lop-Nur testing site across the Kazakhstan border.

Kazakhstan is actively seeking outside help. The NRC recently signed a cooperative agreement with the Kazakhstan Nuclear Energy Organization to exchange technical information on nuclear safety. This agreement will include regulatory cooperation oriented towards improved safety of nuclear installations.

NRC has also recently signed a similar regulatory cooperative agreement with Lithuania. The NRC looks forward to implementing these agreements and believes these cooperative efforts will be as fruitful and beneficial to all parties as our joint ventures with the Russians and Ukrainians have been.

**THE WESTERN RESPONSE TO NIS REACTOR SAFETY**

The United States, western European nations, and Japan are providing contributions to the difficult and costly effort to make Soviet-designed reactors safer wherever they are located. However, what seems clear in Washington, Bonn, or Tokyo looks quite different from the perspective of Moscow or Kiev. NRC's efforts to promote better nuclear safety regulation in the NIS are currently concentrated on Russia and Ukraine.

Former Secretary of State Baker announced a $25 Million U.S. nuclear safety assistance program for the Former Soviet Union (FSU) in Lisbon in May 1992 which included assistance to nuclear regulators in both Russia and Ukraine as a vital element of the initiative. Of the $25 million of FY92 funds from Agency for International Development (AID), about $22 million supports DOE operational safety activities and $3 million supports NRC regulatory assistance. In FY93, an additional $19 million in assistance was made available to continue these activities, about $14 millon for DOE and $5 million for NRC. Another $15 million in FY94 funds is anticipated by NRC.

This Lisbon Initiative began a direct assistance program that focuses on operational safety improvements; risk reduction measures at specific reactor sites, with particular emphasis on higher risk plants, and nuclear regulatory assistance. Although the U.S. Department of Energy has responsibility for the first two parts while NRC has the third, our two agencies cooperate across the board on nuclear safety issues. The NRC program to promote better nuclear safety regulation in the NIS is currently concentrated on Russia and Ukraine and is oriented toward training in licensing, inspection, research, and emergency response, but also includes provision of certain analytical and communications equipment.

NRC trains groups of Russian and Ukrainian regulators at NRC headquarters, regional offices, and the NRC Technical Training Center in Chattanooga, Tennessee. This training is specific and

technical; and, because it is outside their homeland, it offers a different cultural perspective as well. NRC also sends specialists to Russia and Ukraine for on-the-spot training, usually associated with equipment or procedures.

**RESULTS OF COOPERATIVE EFFORTS**

Even before the Lisbon Initiative, the NRC has had a successful program of cooperation with the former Soviet Union through the Joint Coordinating Committee on Civilian Nuclear Reactor Safety which began operations in 1988. In this connection, there have been other tangible results for all. Namely:

- Through 1992, about 50 joint technical meetings with Russians and Ukrainians have led to a better understanding of technical, legal and organizational approaches to safety employed in the West. We believe a positive influence on Russian and Ukrainian safety culture has resulted, making them better able to help themselves improve safety.

- An unprecedented series of exchanges of inspection personnel at nuclear facilities has benefitted regulatory authorities on both sides, broadening our understanding of the regulatory infrastructure in the NIS, and leading to efforts to change some of their policies and practices.

- Russia's Kurchatov Institute's safety research director spent several months at NRC in 1990 to learn how safety research is done in the U.S.

- The NRC provided the Kurchatov Institute with U.S. codes for analysis of severe reactor accidents. In exchange Russia has become a member of the International Code Assessment Program, an association of Western countries interested in simulating reactor accidents to develop effective counter-measures.

- The U.S. learned that the Soviets had specially heat-treated (annealed) several reactor pressure vessels that had become embrittled by radiation and obtained almost complete ductile recovery. This has potential applications to older U.S. plants.

- During tours of Soviet-design plants, U.S. officials noticed that radiation levels were appreciably below those of U.S. plants. Our scientists are working together to evaluate the alloy steels used in Soviet reactor construction to explain these differences, this work may influence the choice of materials to be used in the future.

**NUCLEAR SAFETY REGULATION AND THE GORE-CHERNOMYRDIN COMMISSION**

At their Vancouver summit meeting early last year, Presidents Clinton and Yeltsin proposed a Joint Commission on Energy and Space to be chaired by Vice President Gore and Prime Minister Chernomyrdin. Its purpose was to establish a dialogue between the two governments and a forum for jointly resolving practical problems.

Nuclear power plant safety was one of the key issues discussed at the first meeting in Washington last September. The Vice President's Office, the Departments of State and Energy, and the NRC, took the lead in trying to persuade the Russians to introduce risk reduction measures in, and eventually to close, their least safe plants; give greater autonomy and authority to the regulatory body Gosatomnadzor; improve operational training through the use of simulators; develop emergency operating procedures; complete arrangements for liability protection to enable U.S. industry to provide safety assistance, and gradually replace their obsolete RBMK reactors with modern pressurized water reactors equipped with containment and augmented safety systems based on the model of most western reactors.

On his way to Washington, Prime Minister Chernomyrdin visited the St. Lucie Nuclear Power Plant in Florida. This was arranged by NRC and was intended as a concrete introduction to nuclear safety discussions at the Washington meetings. Later Vice President Gore underscored the need for an independent nuclear regulator. He pointed out that, while responsibility for nuclear safety resides with the operators of the power plants -- not the regulators -- a strong, independent, legally constituted, well-funded safety regulator can assure that the operators devote proper attention to safety. The discussions with Prime Minister Chernomyrdin and his top advisers, both in Washington and Florida, were exceptionally frank and productive, and a number of positive results emerged.

At the second meeting in December, the U.S. proposed and was successful in getting signed a set of Joint Principles of Nuclear Reactor Safety. These principles accomplish two important goals. First, they commit the Russian government to having their national regulatory organization review the safety of nuclear reactors built to earlier standards. This should open the way for Gosatomnadzor to give special attention to the safety of earliest Soviet-designed plants. Second, they commit the Russian Government to formal realization that, in the words of the Principles:

> ". . . safe use of nuclear energy depends upon 1) the establishment of a vigorous safety culture among users of nuclear energy, based on a legal foundation

which defines the activities of a strong and independent regulatory authority; 2) legal recognition of the need for adherence to agreed nuclear safety principles; and 3) an internationally-recognized system of legal liability and financial protection for providing adequate compensation for damage from nuclear accidents and appropriate limitations on third party liability."

This, combined with the Nuclear Safety Assistance Agreement signed by the Secretary of Energy and the Minister of Atomic Energy on behalf of their governments which contains liability provisions, should permit private companies having broad industrial capabilities in the nuclear field to participate in major projects in the Russian Federation.

**ECONOMIC ASPECTS**

Much as we in the West would like to see the many unsafe reactors shut down immediately, it is not going to happen imminently. Consequently, we have been walking a tightrope: trying to reduce the most glaring risk in the old reactors, without thereby encouraging the Russians and others to run those plants any longer than necessary. At the same time, we are trying to redirect their investment toward safer alternative sources of electricity, some of them also nuclear. The financing needs could be large -- some $20 billion spread over eight to ten years; because that far exceeds what foreign aid can supply, commercial financing and considerable domestic effort will be necessary.

Attracting commercial financing requires the assurance of safety; but it requires more. The infusions of Western money Russia so badly needs for its economic development will not be forthcoming if investors believe that Russian facilities are unsafe. But financing also requires economic viability.

That in turn will require full market pricing of electricity, and a gradual phasing out of the subsidies that have so long plagued the Russian economic system, hopelessly distorting business decisions. Until this is accomplished, there will be little incentive for conservation, no spare funds for safety, and no retained earnings to allow repayment of investors. But full pricing will be yet another jolt to consumers. The Russian people are already suffering deeply from the economic dislocations of the last several years. Abolishing subsidies is thus a very difficult step for the Russian leadership.

If anything, the economic situation <u>is even worse</u> in Ukraine. The Russians, at least, can now see economic reforms taking shape, giving them the sense that their suffering over the

last several years has not been in vain. But the Ukrainians, who have suffered just as much, have much less to show for it -- economic reform in Ukraine has not gotten off the ground.

**OPTIMISTIC ASPECTS**

I do not want to leave you thinking that the picture is unrelievedly grim. For all the problems, there are still causes for optimism. Russia is starting to see some real results from its painful economic reforms which makes it more likely that they will understand the need to price energy fully. Additionally, the Russians and Ukrainians are second to none in their scientific knowledge. They are highly educated and highly sophisticated, and indeed, they have reason to be proud of their ability to cope with technological challenges.

The U.S. still has means for positively influencing safety in the NIS, even if we are not in a position to offer large amounts of aid. One incentive is the Russians' intense desire for access to Western markets to sell uranium as power plant fuel. Another is the desire for foreign investment in the energy industries of the NIS, including their electrical generating systems. We keep pointing out that it would not take another Chernobyl to scare off investors -- even a near miss could doom all such investments, probably for decades. I think they are listening, and the results of the U.S.-Russian joint energy alternatives study are being eagerly awaited by our G-7 partners.

Western aid can play a role in creating the climate for attracting long-term, large-scale foreign investment in the NIS, but investment at that level will not be created overnight -- the economic and political uncertainties are just too great. The Western donor nations recognize that, to pave the way for large-scale investment, there must first be short-term successes on a more modest scale to build confidence. Right now the donor nations are investing a great deal of effort, some $300 million in cash, and considerable political capital at home on short-term programs designed both to establish investor confidence and improve the safety of the most glaringly deficient nuclear plants. That is a significant carrot.

But it is a very difficult job. The U.S. offers advice, technical assistance, and trade credits. Our colleagues in the NIS, understandably, would like us to provide the money with no strings attached. Because neither can afford to see this cooperation fail, the talks continue, with the West hoping that the Russians will let rationality and pragmatism drive their decisions, while the NIS hope we will be more realistic and see things more from their point of view, and spend our money over there rather than at home. There is reason to hope that the progress that is being made in these and other areas will serve

to build confidence for cooperation on the more fundamental issues.

Political and financial instability in the NIS increases the potential risk of another nuclear accident and complicates negotiations enormously. But we have turned a corner on these negotiations in the Gore-Chernomyrdin process which greatly increases the stakes for the Russians. A similar inter-weaving of such issues may also work for Ukraine. A breakdown of order in Russia or Ukraine, a further worsening of relations between these proud peoples, would render the problem much worse. The West must continue to press for an integrated approach to all nuclear issues, as we do what we can to support democratic forces in both places. Our self-interest demands it.

But there is reason to hope, for we have glimpsed the light at the end of the tunnel. If the same concept upon which agreement was reached to close the Chernobyl-type plutonium production reactors -- the development of alternate energy sources to replace electricity demand -- can be adopted for the older Soviet-designed reactors, the light will be glowing.

**CONCLUSION**

The nations of the former Soviet Union also have much that they must do on their own. Their position is not enviable. The problems I have described today would be intimidating even for countries enjoying prosperity and stability. The New Independent States have neither. It is only natural that they minimize the importance of these problems when the solutions are painful, emotionally wrenching, and uncertain of success. But they will not go away by being ignored. The problems lie there, oily rags on the floor, and they themselves must bend down and pick them up. If that does not happen and the rags burst into flame, then there is no telling what we will all lose in the fire.

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