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*PRINCIPLES FOR A NUCLEAR SAFETY CULTURE IN TODAY'S GLOBAL
NUCLEAR COMMUNITY*

Introduction

Good Afternoon. I am very pleased to be here today to discuss with you the crucial role a well-developed nuclear safety culture plays in any nuclear power program. This is as true for mature nuclear nations with years of reactor experience, as it is for nations on the brink of developing a nuclear program, a stage which several states in the Pacific Rim are currently entering.

Economic Growth & Electricity Demands in Pacific Rim

The Pacific Rim of Asia, the fastest growing market for electricity in the world, will help determine the scope of world electricity demand for decades to come; fueling an almost 100% worldwide increase of electricity consumption over the next 30 years. The Asian Development Bank projects that the Pacific Rim will spend \$1 trillion by the year 2000, primarily on energy, mainly electricity, telecommunications and transportation.

Given the steep rate of economic development in Asia, nations are scurrying to meet the rocketing electricity demands of this region. The demand for power far outstrips the supply. Several Asian countries depend heavily on imported fuel for generating electricity. Oil supply difficulties in the 1970's led the oil-importing nations of Japan, Korea, and Taiwan to develop well-planned nuclear power programs to ensure the long-term availability of electricity. Even Indonesia, an oil exporting country, could become a net importer by the end of the decade, based on growing domestic demand. At the same time, there is mounting awareness of the environmental consequences of burning soft coal and other fossil fuels, leading many to look for other fuels for electricity -- and in this search for the optimum fuel mix, many Asian countries are looking to nuclear power as a viable option to address the electricity shortage.

The Post-Chernobyl Nuclear Community

As more and more countries embark on nuclear programs, it is important that they know how much the nuclear community has changed since the pre-Chernobyl era. Nuclear programs are no longer simply national programs; nuclear energy has **global** implications -- and international cooperation is key to a successful program. Nuclear technology is no longer produced by autonomous national industries; it has evolved into an international network of scientists and technologists, a single global language, so to speak, with national dialects. The manufacture of nuclear plants is not a national matter; it is an international affair involving the harmonization of national and sometimes sub-national views.

For instance, when we look at China, we see a nation that has attempted to develop its nuclear energy program through indigenous technology and capital resources. China recognizes that this will prove inadequate as she strives to meet her growing demand for electricity across the country; China has recently cited an average shortage of electricity of 20% last year and plans to increase installed nuclear power capacity by 50 Gigawatts by the year 2020. In order to meet this upsurge of energy demands and to strengthen its domestic technology base, China will place a greater reliance on foreign nuclear technologies. For this reason, China is looking beyond its borders and seeking cooperation with Japan, Russia, the U.S., Canada and other European nations.

Furthermore, nations like Indonesia, which has just recently completed site surveys for a nuclear power plant and stated its strong interest in continuing development in the nuclear energy arena, are looking to learn from the experience of the more established, mature nuclear programs.

This, in turn, places a responsibility on the older nuclear programs, given today's global nuclear environment, to share their experience with the newer nuclear programs by continuing in the tradition of international cooperation. It is particularly important that competition be encouraged between vendors, not among nuclear states. National competition, when done by making unfavorable comparisons of various national nuclear programs, has the hazard of breeding chauvinism, protectionism, and unwillingness to share objectively evaluated information. Competition is good as long as we can keep it within its legitimate boundaries: an unbiased, non-chauvinistic comparison of available nuclear designs and technology. Emphasis should be placed on respecting differences in our nation's nuclear strategies and cooperating where there is common ground -- this will serve to benefit everyone.

I would like to make it clear from the outset that the U.S. Nuclear Regulatory Commission (NRC) has no vested interest in whether, or to what degree, any country decides to establish or further develop nuclear power. The right mix of energy sources for any nation depends on many factors unique to that nation, and ultimately must be that nation's own choice. Rather, our interests lie in the development and consistent practice of a vigorous nuclear safety culture. All countries using, or planning to use, nuclear energy to produce electricity share a common interest in achieving the highest levels of nuclear safety in their national programs. Not only could an accident cause radiological damage to its local citizens and to those of neighboring states, but unsafe programs also tend to be un-economical.

Therefore it is vital for each country embarking on a nuclear program to establish, right from the start, a solid safety culture as the cornerstone of such a program as outlined in the International Convention on Nuclear Safety. This is the lesson the world learned from the Three Mile Island and the Chernobyl accidents, and since then, from comparisons of the nuclear safety history of G-7 countries compared to developments in the Former Soviet Union and Eastern Europe. We have learned that it is not only cheaper, but also safer, to establish and implement the necessary safety infrastructure from the beginning.

The community of mature international nuclear programs has a responsibility to cooperate with the newer nuclear programs to help ensure that nuclear power is developed safely from the start. By promoting a nuclear culture in which safety is a high priority in the decision-making process, experienced nuclear societies can greatly influence the attitudes of developing countries. Japan, with the most advanced nuclear program in Asia, shoulders a great share of this responsibility to cooperate closely with its young Asian neighbors expecting to develop nuclear power rapidly in the near future. Masao Hori, Executive Editor of Plutonium magazine, echoes this very idea in the Winter 95 issue: "Over the years, we [the Japanese] have learned a lot of valuable technologies from the U.S. and advanced nuclear-energy states. Now, we must return them with what we can do by way of international cooperation. From our position as one of the Asian nations, we are also expected to do what we can in cooperation with Southeast Asian countries, as they are expected to achieve rapid development in the years ahead."

The U.S. Nuclear Program

I want to emphasize that the U.S. has by no means abandoned nuclear power as a viable option for future energy needs. On the contrary, the U.S. nuclear program is progressing on schedule. Our program of new construction is quiescent precisely because we have already undergone the type of growth Asia is now experiencing, and we don't yet have an increased need for baseload power. Nuclear now generates about 22% of our domestic electricity -- more than double the contribution in 1975. The U.S. produces more nuclear generated electricity than anyone else in the world -- in fact, we generate almost one-third of the world's nuclear electricity. It also appears that our plant life extension program is succeeding, which will help the U.S. continue to reap the full benefit of existing nuclear plants.

As for new reactors, the U.S. NRC has issued design approvals for two evolutionary standard reactor designs -- the General Electric Advanced Boiling Water Reactor and the ABB-Combustion Engineering System 80+ [in July 1994]. In another year rulemaking certification of these designs should be completed, in keeping with worldwide expectations. In keeping with my theme of the global nuclear village, I should note the large Japanese contribution in the GE design and Korean content in the CE design.

Our review of an even newer generation of nuclear power plants is also well along. These novel designs employ passive safety features and modular construction that should make the reactors easier to build and operate, while increasing their economic competitiveness. NRC-certified designs for passive reactors, achieved after an exhaustive analytic and experimental review process of unprecedented thoroughness, should be available later this

decade, well in time for those programs in the U.S. and abroad which are considering using these designs. Again, research conducted here in Japan and in Italy is critical to the success of these projects.

The overall outlook for nuclear power in the U.S. depends primarily on timing of future baseload demand and on the economic competitiveness of nuclear power. The issue is one of economics -- there are no insuperable safety, regulatory, political, or environmental obstacles to new nuclear power plants in the U.S. We believe that this is as it should be -- that economics, and not politics, should determine the choice of power generation technology.

U.S. Cooperation in the Nuclear Community

Given the fact that the U.S. maintains the world's largest nuclear power program (with some 108 reactors in current operation), we have broad experience in the technical, legislative and regulatory aspects of nuclear safety. The U.S. learned the vital importance of the "human factor" in nuclear safety in 1979 after the accident at Unit 2 of the Three Mile Island plant. The former Soviet Union learned an even more painful lesson in 1986 at Chernobyl. In the wake of the Chernobyl disaster and the dissolution of the Soviet Union itself, the NRC has focused much of our nuclear safety assistance on the established programs in the states of Eastern Europe and the former Soviet Union, to help them establish a nuclear safety philosophy based on a strong and independent regulator.

However, not all our international programs are "get-well" programs. In addition, we have expanded information exchange and cooperative programs with Pacific Basin countries. The primary focus has been on providing training, through formal coursework at our Technical Training Center in Tennessee and long-term on-the-job training assignments with NRC staff; on exchanges concerning nuclear safety and technical issues; and furnishing a full library of NRC safety and regulatory documents.

Given my belief in the importance of getting nuclear safety right the first time, our most recent exchange agreements have been with countries considering nuclear power programs, such as Indonesia and Thailand. These agreements have centered on the importance of a strong, independent nuclear safety and regulatory program. It is crucial that safety consciousness be raised at the earliest stages of nuclear development. The U.S. NRC has long provided its support to other governments seeking to improve as well as build nuclear regulatory programs and has established thirty-three regulatory exchange arrangements.

Nuclear Safety Defined

As more and more nations choose nuclear energy as a major energy source, it is important that all the nuclear economies of the world cooperate in regulatory and safety matters -- in addition to continuing cooperation in science and technology. We have found that certain fundamental principles must be followed to ensure a safe nuclear program.

Nuclear safety is like a three-legged chair. If all three legs hold up, the chair will be very stable. But if one leg buckles or wobbles, the chair will tip over. The first leg is technical safety, which is the usual focus of safety and regulatory programs. Technical safety is important, but it is only one of the three legs.

The second leg is economics -- a nuclear program must be well funded; profitable enough to permit continued heavy investment, maintenance, and training; and make good business sense. An uneconomic program will eventually try to cut costs by compromising on safety.

The third leg is organization and management -- training, staffing, safety culture, standardization, responsible leadership, realistic goals, and a solid mandate for safety from the national government.

The safe use of nuclear energy depends on the integration of several factors: economic, scientific, industrial, institutional and legal. One of the most important of these elements is a nuclear safety culture derived from certain fundamental principles that are applicable worldwide. To prove this point, one only has to compare the safety history in the OECD countries with corollary developments in the FSU. Such a comparison will show that one key difference is the role a strong, independent regulatory authority has been able to play in monitoring the nuclear industry's commitment to safety.

With specific regard to the regulatory dimension, four principles are especially important in establishing and maintaining an adequate nuclear safety culture.

First, every nuclear nation must provide a firm legal foundation for a strong and independent regulatory authority to monitor and enforce high levels of safety. Where regulators have not had the independence or political authority to carry out their job effectively, when there is no effective oversight body with the power to close down nuclear power plants for safety violations, there is a tendency to cut corners in order to produce needed power as efficiently and as cheaply as possible.

Second, no amount of regulatory authority is going to be effective if the regulator does not have the resources to get inside the nuclear power program. This means a well-trained and adequately paid staff able to perform on-site inspections, to review plants at all stages from design to decommissioning, and to analyze errors to improve operations in the future. It also means a confirmatory research capability.

Third, both the industry and the regulators must apply rigorous nuclear safety standards such as the principles covered in the International Nuclear Safety Convention.

Fourth, by national law or international commitment, a state must put into place legal liability and financial protection arrangements which would provide adequate compensation for damage in the event of a nuclear accident, while setting appropriate limits on third party liability. Such protection holds both the nation and the nuclear power plant operators responsible for safety while assuring the public redress for any injury it might suffer as a result of negligence or improper operation.

Where these principles have been adhered to from the beginning, a culture of safety has permeated both nuclear operations and management, and this has produced a successful nuclear industry. Where these principles have **not** been followed, the drive to maximize electricity production has too often led the industry to override safety objectives when the two came into conflict.

Role of the International Nuclear Safety Convention

Three years ago, not long after assuming my post as Chairman at the NRC, I spoke at this same forum about the importance of an international nuclear safety convention which would codify the basic fundamentals of an effective nuclear safety regime. In Spring of 1992, formal efforts were just getting underway under IAEA auspices. It gives me great satisfaction to stand before you today and discuss how the International Convention on Nuclear Safety (CNS) is now becoming a reality.

Since the CNS was opened for signature last September, more than 50 countries have become signatories, including the U.S., Japan, China, and many others in the Pacific Rim.

The Convention, which took three years to negotiate, includes principles and standards which both the industry and the regulators must apply, covering all safety relevant aspects of the nuclear fuel cycle. The CNS establishes that it is the license holder, and **not the regulator**, who is ultimately responsible for the safety of the installation it is operating. Nevertheless, the CNS also requires each contracting party to "maintain a legislative and regulatory framework to govern the safety of its nuclear installations." This includes:

- establishing national safety requirements and regulation
- a system of licensing nuclear installations and a prohibition against operating a nuclear installation without a license;
- a system of regulatory inspection and assessment to make sure licensees are in compliance with applicable regulations; and,
- enforcement of these regulations, supported by sanctions that could lead to suspension, modification or revocation of the operating license.

All CNS members are obligated to show they have established an appropriate regulatory and legal framework and each is required to establish a well-funded, strong, independent regulatory body. Moreover, the functions of this regulatory body must be effectively separated from those of any other national "body or organization concerned with the promotion or utilization of nuclear energy." The obligation of each member to submit safety reports for peer review on nuclear power facilities guarantees the exchange of critical information about each member's nuclear power program, its strengths and weaknesses, further enhancing safety cooperation. The Convention therefore serves as an important tool in assuring each member of a safer, more stable global nuclear environment.

The signatories are now developing options for implementing the obligations of the Convention. Experience from the Institute of Nuclear Power Operations, the World Association of Nuclear Operators, and from the various safety missions of the IAEA will be of great assistance in preparing and reviewing individual reports.

Once 22 countries, at least 17 of them with operating nuclear facilities, ratify their signatures, the Convention will come into force, hopefully by 1998.

Japanese Nuclear Power Program

I recognize the challenge to Japan's energy industry in dealing with the pressure to reduce electricity prices -- which are now among the highest in the world. In the U.S., we have also struggled with this difficult issue. I would like to note, however, that we have learned that industry's efforts to trim corners and cut costs, in order to produce electricity as cheaply as possible, must not compromise the bedrock principles of nuclear safety. As I mentioned earlier in my three-legged chair analogy, a nuclear program must be well funded -- the "economics" leg of the chair must remain solid, and the independent regulator given its political authority to do its job, to ensure the program's continued safe, thus successful, operation.

The devastating earthquake that hit the city of Kobe on January 17 demonstrates how important it is for a nuclear power program to be designed from the start to protect the health and safety of the public. The Takahama nuclear power plant, 70 miles northwest of Kobe, was the closest nuclear plant to the epicenter of the quake. I understand that the earthquake, which officials measured to read about 7 on the Richter scale, produced a small tremor that was only 14% of the strength needed to trip one of the reactors because of their advanced seismic designs. The reactors continued to operate throughout the disaster in Kobe.

The steps Japan has taken to make nuclear power safe and therefore successful are the same steps any country developing nuclear power must take. **There can be no shortcuts.** This may not always be a welcome message in developing countries, but it is an essential message nonetheless. Forums such as the International Conference for Nuclear Cooperation in Asia, led by Japan, must continue to serve in carrying this message to countries such as Indonesia, China, Malaysia, Philippines, Vietnam and Thailand.

I see the key factors contributing to Japan's success broken down into the following five basic elements:

- Japan's long-term national commitment to nuclear power,
- large investments in research and development,
- creation and support of academic programs to provide trained personnel,
- aggressive international cooperation and information exchange, and
- a favorable operating environment for utilities.

These elements have resulted in one of the highest standards of excellence in the world for its nuclear program involving 48 reactors operating at 17 sites, and providing over 30% of the nation's electricity. Although Japan is grappling with two issues that all mature nuclear nations must deal with, that is, the location of new sites and the disposition of spent fuel, Japan still plans to almost double its nuclear generating capacity by 2010.

One element that has greatly enhanced the success of Japan's nuclear program -- an element I believe crucial in today's nuclear environment -- is its cooperation with the global nuclear community. U.S. technology has contributed greatly to Japan's nuclear industry, and

the reverse is also true. Japan has benefitted greatly from this technology transfer; in fact, all Japan's LWRs are based on designs originally licensed in the U.S. Japan continues to be one of the U.S. NRC's most active partners in nuclear safety exchanges, involving cooperative research, information on regulatory programs, and exchange programs involving personnel and training. Because nuclear regulatory responsibilities are split between two Japanese government agencies, NRC has regulatory information exchange agreements with both the Ministry of International Trade and Industry (MITI) and the Science and Technology Agency (STA). Since 1982, there has been an exchange of regulatory personnel between NRC, MITI, and STA which has contributed to daily dialogue on safety matters. NRC also has extensive research agreements with several Japanese agencies. In fact, Japanese research institutions are playing a significant role in conducting and confirming research for NRC on passive-safety system performance.

Continuing exchanges foster the spirit of nuclear safety cooperation. It is important that we continue with this tradition and guard against chauvinism, protectionism and undue competition. Respecting differences in our nations' nuclear strategies and cooperating where there is common ground will benefit all parties involved. Only then will attention be focused on areas where we can mutually gain; reaping benefits from this cooperation not only for our respective countries, but for the international community as well.

China's Nuclear Power Program

Given Japan's proximity to the Peoples Republic of China, I'm sure that China's nuclear program is being watched closely. The demand for electrical energy is outrunning supply by more than 20% in China. And to meet this demand, China's nuclear energy plans for the future are ambitious. During the past two years, China placed three nuclear power plants into operation -- two 900-MW PWRs of French design at Daya Bay, and one 300-MW PWR unit of indigenous design at Qinshan -- and is already planning several additional reactors, including four 600-MW PWRs at Qinshan, and four additional 900 MWe units for the Daya Bay area. By the turn of the century, China expects to have 10,000 megawatts of nuclear power operational or under construction and it plans to install 150,000 megawatts of nuclear power by 2050. China's plans, if followed through, would result in one of the largest nuclear programs on earth.

China is well aware that extensive foreign capital is necessary for almost any large-scale expansion of electricity in a developing country. Since foreigners will not invest in the industry if safety isn't assured, a strong regulatory program is important for both the sake of attracting capital as well as for safety. And China is clearly taking nuclear safety seriously. Several weeks ago, U.S. Secretary of Energy O'Leary successfully presided over the signing of several contracts and accords for the American power-generation industry during a six-day visit to China, accords which will also have the helping side effect of increasing communication between China and American organizations that have fire safety experiences to share with China.

At China's invitation, last year the IAEA conducted a review of its nuclear regulatory system. The review team found that China's regulatory system corresponds to those in use worldwide and that its program meets international guidelines. This is very encouraging.

Nonetheless, there is still cause for concern. As the production side of China's nuclear program expands, China will need to ensure that its regulatory capability does not lag behind. I see four issues that I see becoming increasingly important: regulatory resources and authority, design standardization, transparency, and coordination of emergency preparedness. These are factors crucial to the viability of any nuclear program worldwide:

Resources and Authority: One key resource is an adequate number of well trained and highly competent staff. As the number of nuclear plants multiplies, the regulator will need greater numbers of personnel to be able to keep up in any meaningful way. To ensure retention of competent staff, it is crucial that salary levels for regulatory personnel be set at a level comparable to industry salaries. A related issue is independence and authority. If the regulator does not have the final authority on whether to license operations or to close a reactor for safety violations, its effectiveness will be seriously limited.

Standard Reactor Designs: Efficiency can be achieved by limiting the construction of nuclear plants to a few standard reactor designs. With 41 nuclear utility companies and 109 individual reactor designs, the U.S. knows first-hand the large number of people required to regulate effectively a variety of reactor types. For a regulator to be able to maintain an adequate base of knowledge and confirmatory research capability, it is imperative that nations new to the nuclear market limit plant construction to just a few standard reactor designs. Indeed, the U.S. is now moving toward standardized designs.

Transparency: A third issue central to nuclear safety, commonly referred to as transparency, is the reporting of all nuclear incidents both to the domestic public and to appropriate international oversight organizations. The number of incidents, even minor, is one of the best objective indicators of the state of a nation's nuclear safety program. Not only is the public entitled to this information, but investors need this information to help determine if their investment is safe and secure.

Emergency Preparedness: Lastly, coordination of emergency preparedness is critical to any serious nuclear safety program. Emergency planning and response during the early phase of an accident are particularly important for plants in highly populated areas and for plants near international borders.

U.S. - India Nuclear Safety Cooperation

Nuclear safety is of such vital importance globally that it should be possible to conduct a colloquy on this issue with any country, irrespective of cultural and political differences.

Just a few weeks ago, I had the opportunity to visit India, continuing a nuclear safety dialogue begun last July. My visit was a follow-on to an earlier visit to the U.S. by Dr. A. Gopalakrishnan, Chairman of the Indian Atomic Energy Regulatory Board. While in the U.S., Dr. Gopalakrishnan's delegation conducted technical discussions with NRC staff, visited the NRC's Technical Training Center in Chattanooga, Tennessee, toured a U.S. nuclear power plant, and concluded the trip with meetings at Brookhaven National Laboratory. In turn, while in India, I met with a cross section of Indian political, energy and nuclear power officials, and, with my delegation, was given a useful opportunity for access to one of their indigenous nuclear power plants (Narora) and the nuclear research facilities at the Bhabha Atomic Research

Centre (BARC), as well as to review current operation of the Tarapur Atomic Power Station with its General Electric manufactured reactors.

In the wake of what India has characterized as a peaceful nuclear explosion in 1974, nations which had previously conducted broad-scale nuclear cooperation with India (including the United States) adopted more stringent non-proliferation technology controls on exports to nations--like India--which had not accepted IAEA safeguards over their entire civil nuclear programs. This development forced India to turn more inward in its nuclear program, giving it a more "indigenist" character. This situation has had the undeniable effect of preventing Indian nuclear scientists and engineers from benefiting fully from the most current work in the rest of the nuclear world in areas important to safe operation of nuclear plants. However, this relative isolation has also meant that the Indian nuclear program has explored some different approaches to technical issues.

As India stands on the brink of unprecedented growth and prosperity, a factor directly impacting its ability to sustain this growth will be the availability of safe, reliable and economical electric energy. India at present is facing an energy peaking shortage on the order of 20%, which is likely to persist until adequate capacity can be added for meeting the rapid growth in demand for electricity. Nuclear power is part of the mix the Indian Government will draw upon to meet that need. As it presently exists, the Indian program is too small to make a real contribution to India's large and growing energy needs, but large enough to pose significant safety risks, if not implemented to the highest levels of safety. The Indian nuclear program has developed a sufficient number of well-trained nuclear personnel. It has a strong legal basis, and with recent changes in government, has developed an openly aggressive regulatory infrastructure.

Conclusion:

In conclusion, I wish to emphasize that the nuclear safety program as we knew it in the pre-Chernobyl era has changed from several national individualized programs to a global one. Active participation in today's international nuclear community is key to ensuring a successful nuclear program in any nation. Competition needs to stay confined to where it legitimately belongs: an unbiased comparison of available nuclear designs and technology. Competition by tearing down each other's national nuclear programs, however, will only serve to bring out prejudices against nuclear energy and ultimately undermine confidence in nuclear power. In the end, we would all miss out on the benefits of nuclear safety cooperation. Only by continuous involvement in the global nuclear community can the mature nuclear economies achieve what we all are striving for -- a healthy international nuclear economy and safety culture which fosters the safe development of nuclear power. And the International Convention on Nuclear Safety is one instrument which opens the way to this achievement. Let us continue working together toward this end.