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FUNDAMENTAL PRINCIPLES OF SAFE NUCLEAR DEVELOPMENT

INTRODUCTION

I am very pleased to be here today to share with you some perspectives on global nuclear energy safety.

I believe that nuclear safety is of such vital importance globally that it should be possible to conduct a colloquy on this issue with any country, even if it is not possible to engage in broader nuclear commerce. This international cooperation allows different perspectives developed through reactor design and operation to be used to improve global nuclear safety.

It is in this context that I would like to talk about the NRC views on global nuclear safety, and on what I see as the challenges facing the Indian government as they strive to improve the safety of their operating and planned reactors.

SAFETY PHILOSOPHY

Nuclear safety is like a three-legged stool. If all three legs hold up, the stool will be very stable. But if one leg buckles or wobbles, the stool 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.

Every solid nuclear program must be based on solid economics less obvious but equally true -- today there are no national programs anymore -- there are just national flavors of an international shared program. And finally, a strong regulator is needed to make sure that the promoters and operators focused on safety. With specific regard to the regulatory dimension, three elements 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 traditionally 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 to produce needed power as cheaply as possible.

Second, no amount of regulatory authority is going to be effective if the regulator does not have the necessary resources at its disposal. This means a well-trained and adequately paid staff to perform on-site inspections, review plants at all stages from design to decommissioning, and analyze errors to improve operations in the future.

Less obvious but also important, the regulator should have access to an independent, regulatory research program, to support an investigation of risks, accidents, siting, and such everyday items as corrosion, training effectiveness, or vulnerability to fire.

Third, both the industry and the regulators must apply rigorous nuclear standards which cover all aspects of the nuclear fuel cycle. One such set of principles has been developed for the international Convention on Nuclear Safety, which was opened for signature last September. I am pleased to note that both India and the U.S. were among the first signatories.

I also think the regulator should have the authority to turn these rigorous standards into the mandatory regulations that all operators must follow.

Finally, by national law or international commitment, a state must put into place legal 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 accountable for protecting the public health and safety, while assuring the public every right to redress any injury it might suffer as a result of negligence or improper operation.

NUCLEAR PLANT SAFETY

The foundation of nuclear safety rests firmly within the principle of "defense in depth". This concept has provided the underpinnings of the U.S. nuclear program from its inception. Key to this approach is to provide and maintain multiple layers of defense for expected as well as unlikely nuclear plant upsets and accidents.

Such a philosophy requires the plant designers, operators and regulators to pay equal attention to accident prevention, mitigation and emergency planning. As you can see, defense in depth constitutes its own three legged stool, each of which must be sturdy to maintain the benefits of a layered safety philosophy. Ensuring the strength of each leg just requires application of sound engineering. But a questioning approach, seeking to identify and anticipate design or operational vulnerabilities, is also necessary.

Accident prevention forms the first layer of defense in depth. In the case of the U.S., our General Design Criteria and Standard Review plan establish the basic design standards. These standards ensure adequate levels of system redundancy, separation between systems to ensure that a fault (such as flooding or fire) in one safety system does not affect another, and quality standards to ensure that the capability of a component is commensurate with its safety importance.

The implementation of defense in depth in the design process by U.S. vendors has in some cases gone beyond the explicit requirements of our regulations, which we consider only as a floor for good practice. Incorporation of such features as steam turbine (rather than electric), feedwater and primary makeup systems, or isolation condensers, provides a diverse and independent means of cooling the core if loss of offsite power and emergency generator failure were to occur. Probabilistic risk assessment studies have shown significant benefit can be achieved from such diversified systems.

Mitigation is the second tier of our defense in depth structure, resulting in such features as robust containments, hydrogen control systems, and atmospheric scrubbing systems. These features reduce the severity of consequences and offsite doses in the unlikely event of a design basis or beyond design basis accident.

The benefits afforded by strong primary containments were graphically shown by the most severe commercial nuclear accident in the U.S. at Three Mile Island (TMI). Even with the severe fuel damage at TMI, the primary containment essentially prevented any consequences to the general public and allowed the operating staff to respond to the accident effectively.

A strong and effective Emergency Planning (EP) program completes our defense in depth approach by ensuring that procedures and facilities are in place to alert the public following an accident, and guide them in an effective evacuation or other appropriate response. Such a program requires that interfaces between federal, state and local authorities be clearly defined, and that command and control authority with the plant operations staff be unambiguous. To validate the effectiveness of such plans, NRC holds periodic emergency drills involving both utility and governmental personnel.

Ensuring that all desired levels of defense in depth are maintained requires vigilant attention to operating experience feedback. It has often been demonstrated, regrettably sometimes in hindsight, that serious plant incidents are preceded by predictive precursors. A strong program of assessing operating experience, and listening carefully to the lessons it tells us is probably the single most important element of an effective industry safety culture. Insights gained from operational events have enabled us to reduce the dangers from anticipated transients without scram and station blackout.

However, I must emphasize that reviewing operating events alone does not provide the insights to respond effectively. A strong research and analytical capability is needed to assess the safety significance of observed events, and to extrapolate their potential progression into lower likelihood, but higher consequence, scenarios. An independent regulatory capability in this area is essential.

The NRC's Accident Sequence Precursor (ASP) program applies probabilistic safety assessment (PSA) methods to determine the risk levels of the most significant operational events. This information guides us to focus on the most safety significant, and potentially most hazardous issues.

I believe this structured process shows that we are careful listeners to the lessons coming from plant experience.

I am also encouraged by the increasing use being made of PSA methods by the U.S. industry, as well as by U.S. regulators.

Investigations into the likelihood and consequences of severe accidents gives us a unique ability to gain insights on scenarios too infrequent to appear in operating experience. The NRC pioneered the development of PSA methods during early reactor studies.

Insights from such studies have directed us to address containment performance with actions that enhance performance and survivability in a severe accident environment. Incorporation of hardened vent pipes in BWR Mark I containments, hydrogen ignitors in Mark III containments, and reactor cavity flooding systems for some advanced designs, are a few examples of these actions.

Additionally, I am very pleased that all U.S. utilities are in the process of completing Individual Plant Examination (IPE) studies. The IPE use PSA methods to identify any potential severe accident vulnerabilities. When complete, these studies will consider both internal event risk, as well as seismic and fire vulnerabilities. The information from these studies allows our industry to make cost effective safety improvements related to specific vulnerabilities of plants as built.

Even with the activities I have described to ensure nuclear safety, I see that our challenges will continue, as will the need for strong regulatory oversight. Issues related to plant aging stretch ahead of us, and will need to be followed very closely. U.S. examples of identified aging problems include cracking of boiling water rector internals, stream generator tube cracking, and questions over reactor vessel pressurized thermal shock.

A continued focus on plant operations is essential to establish how effective our oversight is. Issues that we believed were solved, such as station blackout, are still appearing in PSA studies as potential risk contributors. We need to stay vigilant to ensure that our safety solutions to problems prove effective. Even after the great effort given to plant fires after Browns Ferry, we are experiencing significant problems with the effectiveness of time rated fire barriers, as opposed to true separation, to prevent propagation of fire to redundant safety trains -- issues that are familiar to you from the Narora incident.

The questioning attitude I spoke of earlier encourages us to continue the process of assessment and self assessment, and to ensure that we deal with these issues effectively.

THE ROLE OF THE INTERNATIONAL CONVENTION ON NUCLEAR SAFETY

Just as nuclear technology is no longer produced by self-sufficient, separate national industries, nuclear safety also is no longer simply a national concern. Therefore, in addition to strong national regulation, the U.S., like India, has supported placing the principal elements of nuclear safety regulation into the international Convention on Nuclear Safety (CNS).

Wide adherence to this instrument will help assure a safer global environment. Safer, not solely because of guiding principles that participants are obliged to follow, but safer also because of the reporting and peer review processes implemented by the CNS.

The Convention requires each contracting party to "maintain a legislative and regulatory framework to govern the safety of its nuclear installations." This is to include, as I outlined earlier:

- establishing national safety requirements and regulation;
- a system of licensing nuclear installations and a prohibition on 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.

Each party to the Convention is required to establish or designate a non-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."

Finally, there is an obligation to inform the public, since it is the public, as citizens of the land, who ultimately ensure the safety of their nuclear power program by demanding a strong and independent regulatory program.

The signatories are now developing options and alternatives for implementing the obligations of the Convention. Under Dr. Chidambaram's leadership, and side-by-side with the U.S., India will continue to help shape the mechanisms by which this Convention will guide the safe use of nuclear power globally.

Questions India may wish to ask itself about Nuclear Power

During my visit I have learned that the Indian Atomic Energy Regulatory Board (AERB) has only 80 professional employees to inspect and regulate India's nine-unit nuclear power program. The Atomic Energy Commission (AEC) and the Department of Atomic Energy (DAE), to which the AERB reports, control not only promotional and regulatory functions, but also implement the Indian military nuclear program, much as the Department of Energy in the U.S. administers the U.S. military nuclear weapons development program. The AERB does not yet have the full regulatory independence India obligated itself to having when it signed the Convention on Nuclear Safety.

Nuclear Power in India, as in the U.S. in the 1960s, is at a crossroads. Like the U.S., it could ask itself several questions which are relevant to the successful long-term future of nuclear power. Does the institutional environment allow the functional independence necessary for a safe, effectively regulated nuclear program? Are sufficient resources dedicated for the regulator to implement its mission? Does the nuclear program have adequate financial and human resources to safely operate and maintain the expensive infrastructure?

IN CONCLUSION

For reasons I have already stated, over the past two decades India's nuclear program has gone its own way, largely separate from the worldwide nuclear community. This has created problems; however, it also presents opportunities. India has developed much of the infrastructure so essential to the safety and successful development of nuclear power, in a way that is somewhat different from current international technical or safety thinking. It is in these areas that we can begin to jointly work, within the limits of our different political, economic, and technological systems. The NRC is encouraged by the exchanges we have engaged in since July 1994, and wishes to actively continue in this reciprocal relationship.

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