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The International Nuclear Technology

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ABSTRACT

With today's technology, isolationism is virtually impossible. The world's economies are so strongly intertwined that what affects one country will, in some way, influence another. Nuclear technology is no exception. If anything, nuclear technology is a catalyst for international cooperation. In the United States, nuclear technology is undergoing significant changes. Many of these changes are being greatly influenced by programs of international cooperation.

CONFERENCE THEME - "WITHOUT BORDER"

Recent international events have transformed the world into a more harmonious place in which to live. Modern travel and communications have improved our understanding of one another. Events in far reaches of the world appear as if they occurred in our own backyard. More and more, we realize that our actions can have international impact. In many ways, we are becoming one large international neighborhood.

Nuclear technology, that issue which brings us together in this beautiful setting of Taipei, has become an international technology. Both its successes and failures are known to transcend international borders. The theme of this Conference, "A High Technology without Border - Nuclear" is descriptive of the fact that nuclear technology is an international happening. For these reasons, I take the liberty of addressing this distinguished international group as "technical neighbors."
In the past 20 or 30 years, Japan and Korea have become major suppliers of reactor components. Beautiful Taiwan, hosting this conference, is a member of the nuclear community. Beijing, China and Mexico have become involved in operating nuclear power plants. Within a short time, Indonesia may begin its nuclear power program as well.

We all have come a long way. People from different cultures are working together as technical neighbors and friends. We have become technical neighbors sharing information for the betterment and safety of the neighborhood in which we live, the planet Earth.

In the United States, the Nuclear Regulatory Commission has been very active in stimulating information exchanges and supporting cooperation arrangements with international organizations. In the past seventeen years, nearly 200 nationals from 26 counties have completed two-month to two-year assignments at the Nuclear Regulatory Commission, both learning from and contributing to the efforts of our agency. In recent years, these assignments have focused on inspections, safety assessments, radiation protection, emergency preparedness, operational data evaluations, accident analyses, and advanced reactor research.

The Pacific Basin member states which have participated in these programs include Hong Kong, Indonesia, Japan, Korea, Philippines, Beijing, China, and our host, Taiwan. Other countries include Czechoslovakia, Denmark, Egypt, Finland, France, Germany, Israel, Italy, Morocco, Poland, Portugal, Spain, Sweden, the former Soviet Union, Turkey, and Yugoslavia. We at the NRC have learned much from this international interaction.

INTERNATIONAL COOPERATION

There are many advantages and benefits to working together cooperatively as technical neighbors in this international technology. I will briefly mention three.

The first, and most valuable, is that cooperation among various international entities having diverse expertise and experience often leads to more innovative and balanced solutions to common needs and problems.

The second benefit is that cooperation among international entities with common goals facilitates communication and the exchange of information for the common good.

The third benefit is that cooperation among international entities responding to the same problems, demands, or needs, helps conserve resources and helps prevent wasteful bureaucracy by heading off the "not invented here" syndrome, where each entity thinks that only it can find the best solution to the problem at hand.

The continuing need for additional energy and the concern over protecting our precious environment makes nuclear energy an option for serious consideration. It cannot be lightly discounted. However, international technical cooperation is vital to the continued use of the nuclear technology for the betterment of mankind.

SATISFYING THE INCREASED NEED FOR POWER

In the United States, projections by the Department of Energy forecast possible instabilities in electricity supplies during peak load demand as early as 1994 in certain regions of the country.

This is attributed to reduction of reserve margin of electric generating capacity. In order to maintain a stable electric power supply, the U.S. electric industry needs to order large base load generating capacity within the next three to four years. It is therefore not surprising that, in the United States, the nuclear industry is actively working to contribute to meeting the country's future energy needs.

The President of the United States and the electric power industry in the United States have taken the position that nuclear power must remain a viable option for generating electricity.

As Eastern Europe, Africa, Asia and the Americas increase their manufacturing capabilities and standard of living, the competition for fossil fuels will intensify, concerns over our environment will increase, and the need for electricity will continue to grow.

Statisticians are projecting that the world population will double by the year 2010. Even assuming that the consumption rate of electricity remains constant per capita, one can easily predict the need for expanded energy supplies and the associated competition for energy resources.

However, the need for energy by itself is not enough for the nuclear technology to be the option chosen for generating electricity. The continued safe operation of existing plants is a requisite. In addition, the reactor vendors must regain the confidence of the potential purchaser and consider the lessons learned from the past in the design of any new product line. It is therefore important that utilities clearly identify to the reactor vendors their experiences, expectations and requirements for the next generation of nuclear power plants.

I am pleased to note that several of the Pacific Basin Members, such as Taiwan, Korea, and Japan, are active participants in the U.S. industry's development of a utility requirements document. This initiative is being coordinated by the Electric Power Research Institute (EPRI) and defines the utilities' expectations and demands for the next generation of nuclear power plants. Other participants in the development of this document include organizations in France, Italy, and the Netherlands.

It is gratifying to note that the reactor vendors in the United States are also actively participating with the Electric Power Research Institute (EPRI) to ensure that the utilities' perspectives and needs are incorporated in the design of the next generation of nuclear power plants. It is also gratifying to note that other technical neighbors, such as Indonesia, Italy and Japan, are active participants in the U.S. vendors' development of the advanced reactor designs.

Simplicity, significant safety margins, capability to ride out anticipated transients at power without shutting down, human factor considerations, and maintainability are but a few of the capabilities potential purchasers expect and demand from any new reactor design. The U.S. industry, with assistance from the Department of Energy and international participants, is actively working to maintain the nuclear technology as a viable option for generating electricity.

Will other nations need to rely on nuclear power? Judging from discussions with international authorities, I would say that the answer to this question is a definitive "*yes*." However, the decision to maintain or increase the world's nuclear generating capacity is for others, not the NRC, to make.

Some of the Republics of the former Soviet Union have active programs to expand their reliance on nuclear power; Beijing, China has a program to expand its electric generating capacity with nuclear power; and the European Community countries are investing in new evolutionary reactor designs and technologies.

Just a few months ago, the Japanese began constructing two units of General Electric's Advanced Boiling Water Reactor. The South Koreans decided to build two units of ABB-Combustion Engineering's System 80 plants. Similarly, Taiwan has announced plans to expand its nuclear program.

In the United States, the American Electric Power Company announced that it is actively considering whether to purchase a Westinghouse Advanced Passive 600 Mwe power plant, known as the AP-600. The Tennessee Valley Authority (TVA) is actively looking into new reactor designs for meeting its thirsty 600 Mwe yearly growth in demand, and announced its need to reach a decision, possibly next year, on future generating capacity. The Tennessee Valley Authority went so far as to state that it may be the first U.S. utility to order one of the next generation of nuclear power plants.

The Nuclear Power Oversight Committee (NPOC), representing the nuclear industry in the United States, has emphasized in its report entitled, "Strategic Plan for Building New Nuclear Power Plants," that the industry wants to maintain the nuclear option for the future. The industry is aiming toward having some U.S. certified nuclear plants operating in about eight years.

If this is the direction the industry decides upon, the NRC will do its part to ensure that it fulfills its regulatory responsibilities.

INCREASED STANDARDIZATION OF PLANT DESIGNS

The United States Nuclear Regulatory Commission (NRC) has been planning since the early 1980s its strategy for licensing advanced light water reactor designs. Partly in response to public concerns that plants have been licensed with some safety issues unresolved; that plants have not been constructed in accordance with requirements; and that the regulatory process was too unstable to risk the investments necessary to order, construct and operate nuclear power plants, the Nuclear Regulatory Commission issued in 1989 a new rule on early site approval, design certification, and combined construction and operating licenses, known as 10 CFR Part 52. This rule will greatly enhance standardization of future U.S. plants. This new regulation was enacted to enhance both safety and regulatory stability. Let me briefly describe the new regulation for those of you not familiar with it.

The new rule provides for a vendor's final design to be certified by a Commission rulemaking process. It provides *finality* to the resolution of the technical issues considered during the certification rulemaking. Consequently, those technical issues will be treated as resolved for any hearing pertaining to a license requested by a utility to construct and operate a certified plant.

In February 1991, the Commission approved the concept of a two-tiered approach to the certification of standard designs. Tier 1 would contain the certified portion of the design. Tier 2 would contain any other elements of the design approved in connection with the certification. Also, the Commission approved a process that would permit a holder of a combined license to make limited changes to material in Tier 2.

Such a process will give a licensee the flexibility to replace equipment no longer available on the market with functionally equivalent equipment, to accommodate normal deviations during construction, and to upgrade its facility through enhanced technologies and engineering.

In exchange for this flexibility licensees will be required to consider whether the proposed change would raise unresolved safety questions, and will be required to preserve the severe accident, human factors, and operating experience insights embodied in the certified design.

On a non-regulatory track, the industry, through its Nuclear Power Oversight Committee, is actively developing a program which will ensure that the benefits of maintaining standardization are considered in any changes made under this process.

MODIFICATION OF PAST LICENSING PRACTICES

Perhaps some of you have been following in the trade press the Commission's debate on the issue of the level of detail required from an applicant for certifying its plant design. The Commission has consistently argued that a level of design detail is required which would permit the resolution of all safety issues at design certification. The Commission has also emphasized the importance of conducting thorough reviews of the new designs. Even with this emphasis, there are skeptics who claim that the NRC is conducting its reviews as in the past, or in a "business as usual" fashion.

In response to those criticisms, I would like to emphasize that the reviews under the new regulation are in no way being conducted in a "business as usual" fashion. The Commission is committed to its new licensing regulation for certifying vendors' designs. This regulation greatly expands the breadth of the technical information previously required of applicants. For example:

- the new regulation expands the review of the balance of plant;
- it requires incorporation of probabilistic risk assessment into the design and decision making process;

- it requires design-specific resolution of severe accident issues;
- it requires resolution of all medium and high priority generic safety issues;
- it requires the preparation of the "Inspections, Tests, Analyses, and Acceptance Criteria," known as "ITAAC," which are to provide reasonable assurance that a plant which references a certified design is built and will operate in accordance with the design; and most important,
- it requires resolution of all safety questions associated with the design.

These are more detailed and stringent requirements than have ever been imposed on applicants in the past.

These requirements were promulgated in part to heighten regulatory stability by ensuring that all non-site-specific safety issues are resolved before certification. Stability in the regulatory process is vital to any corporate and public decision to invest the massive resources required to purchase, construct and operate a nuclear facility.

In the past, new generic safety issues were raised during construction. The resolution of these issues often led to significant backfitting which had to be completed before operation began. Under the new regulation, all safety issues will be resolved before construction.

In the past, some operating licenses were granted with unresolved confirmatory issues. Under the new regulation, that practice will not exist.

In the past, issues would arise during construction over the adequacy of the methods used in the construction. Under the new regulation, the inspection carried out during construction under a combined license will be based on the tests, inspections, analyses, and related acceptance criteria (ITAAC) proposed by the applicant, approved by the staff, and incorporated in the combined license prior to construction. The combined license will also identify the regulator's requirements for authorizing plant startup.

This new ITAAC process is a *major* change and improvement in the licensing process in the United States. The prospective utility licensees should find this regulation highly useful when selecting a nuclear facility, for it significantly reduces major uncertainties in the regulatory process.

In the past, the NRC did not review and approve offsite emergency plans until construction was nearly completed. Under the new regulation, construction cannot begin until emergency plans are approved. This significantly reduces a major uncertainty in the regulatory process in the United States.

Since this is a new process, onlookers should not be surprised or concerned to hear debates in the United States as the NRC and industry implement the new regulation for the first time.

I believe that this process will significantly enhance the confidence of the general public, the regulators, and purchasers that plants built in accordance with a vendor's certified design and a utility's license will fulfill expectations of safety and performance.

I am proud and confident of the United States' renewed leadership in advanced reactor technologies, and the international participation in this effort, and I believe that the new licensing process the Commission has established will help ensure enhanced safety, provide greater regulatory stability, and help increase public confidence in the technology and the regulatory process.

ADVANCED REACTORS DEVELOPMENT

As you may be aware, the United States Nuclear Regulatory Commission is reviewing two standard nuclear plant designs for design certification. The lead plant in the certification process is General Electric's Advanced Boiling Water Reactor (ABWR). Close behind is ABB-Combustion Engineering's System 80+ design. These large (approximately 1300 Mwe) plants incorporate evolutionary improvements of the designs now in operation.

These designs will incorporate features which address severe accident issues and must meet the intent of the Commission's Policy Statements on Severe Accidents and Advanced Reactors. For example, in June 1990, the Commission directed the staff to ensure that several severe accident issues are addressed in the design of the evolutionary plants. These issues include:

- hydrogen generation control,
- core-concrete interaction and the ability to cool core debris,
- high pressure core melt ejection,
- fire protection,
- intersystem LOCA,
- station blackout,
- anticipated transient without SCRAM,
- mid-loop operation during refueling, and

o source terms.

The NRC is also reviewing preliminary design information for the Westinghouse Advanced Passive plant known as the AP-600, the Advanced General Electric Simplified Boiling Water Reactor (SBWR), the ABB-Combustion Engineering plant known as PIUS, and AECL Technologies' CANDU-3. These designs implement features which rely much less than today's operating plants on active intervention by man or active machinery in response to abnormal and accident events. The NRC expects to receive applications for design certification for the AP-600 in June of this year (1992), the SBWR in August of this year (1992), PIUS in 1993, and CANDU-3 sometime in the next several years.

The advanced light water reactors are being designed to be significantly more robust in their response to phenomena which would only occur under severe accident conditions. The Commission expects that, through the use of probabilistic safety analyses during the design process, challenges to the system which could lead to a severe accident will be significantly reduced from what they are in present generation reactors.

The industry is incorporating design features which not only consider the NRC's requirements, policies, and Safety Goals, but go further by addressing additional improvements to prevent and mitigate severe accident events. The industry believes that these improvements are necessary to protect its investment and to obtain public confidence that the designs not only meet, but exceed, regulatory requirements. In addition, the industry will incorporate, and the NRC will review, human factors considerations in the plant design for normal plant operation and emergency conditions.
The NRC expects to complete a Final Design Approval Safety Evaluation Report for General Electric's Advanced Boiling Water Reactor in December of this year (1992), for ABB-Combustion Engineering's System 80+ in November 1993, for Westinghouse's Advanced Passive plant (AP-600) in November 1984, and for General Electric's Simplified Boiling Water Reactor (SBWR) in January 1995. The certification date for a given design is projected to be 18 months after the issuance of the Final Design Approval safety evaluation report for the design.

Both the regulators and the industry are actively defining and resolving new issues which were previously not encountered in licensing: issues such as the form and content of the certification rule; the form and content of the inspections, tests, analyses and acceptance criteria by which the construction will be judged; the nature of the phased inspection program -- called the "sign-as-you-go" process -- which the NRC will use during construction; and the procedural details of the new licensing process, including the partially revised public hearing process.

Onlookers should appreciate that the new requirements for certifying a reactor design in the U.S. are different from past practices. The industry has made innovations and improvements in the designs; the regulator has made improvements in the licensing process; and the design activities incorporate input from international experiences and perspectives.

LICENSE RENEWAL

Review and licensing of advanced reactor designs are only two of the recent activities important for meeting the future energy needs of the United States. As plants begin to reach the expiration date on their license (forty years in the United States), the nuclear utility industry will have to consider means for replacement power. For planning and construction purposes, this activity normally begins 10 to 15 years prior to building replacement plants.

In November 1991, the Commission affirmed a new rule, known as 10 CFR Part 54, which establishes the procedures, criteria, and standards governing nuclear power plant license renewal. As this topic will be discussed in considerable detail in a later session, I will not elaborate on this rule, other than to emphasize one important point. The cornerstone of this regulation involves research activities that identify the mechanisms by which equipment degrades as a function of time. Examples of such research activities include, but are not limited to: aging studies on containment concrete, motor operated valves, and reactor pressure vessel nozzles; piping integrity research; programs for inspection of steel components; radiation damage mechanisms; environmentally assisted cracking; irradiation assisted stress corrosion cracking; primary system integrity evaluations of the reactor pressure vessel, piping and steam generators; nondestructive examinations; and elastic-plastic fracture of inhomogeneous materials. These research activities are not only applicable to license renewal but can significantly contribute to the safe operation and increased availability of present operating reactors. These research activities symbolize the spirit of international cooperation among our technical neighbors, through active participation in these programs.

The Pacific Basin member states which participate in these programs include: Canada, Korea, Japan, and Taiwan. Other technical neighbors in these programs include Belgium, Czechoslovakia, France, Finland, Germany, Hungary, Italy, Spain, Sweden, Switzerland, the United Kingdom, and the former Soviet Union. This list is not all-inclusive, but is illustrative of what is meant by "A High Technology without Border - Nuclear," where technical neighbors work together.

DECOMMISSIONING CRITERIA

As nuclear facilities continue to mature and age, licensees will have to focus their attention on decommissioning. Some sites where nuclear facilities exist may need to be restored for other useful purposes. However, residual contamination criteria are needed to ensure that the sites are safe for the other uses.

The NRC does not currently have specific regulations specifying the numerical criteria for the decontamination and decommissioning of nuclear facilities. Instead, the NRC has been relying on an assortment of regulatory guides, branch technical positions, and specific case-by-case guidance to individual licensees. All of this guidance is directed at being able to release a site or facility for unrestricted use. The guidance provided in these documents ranges from qualitative

criteria, such as limiting radiological dose to "a few millirems," to specific quantitative concentration levels.

The NRC is now embarking on developing quantitative criteria for decontamination and decommissioning of nuclear facilities in the United States. When completed, these criteria will enable the NRC to evaluate a licensee's request for decommissioning a facility when it reaches the end of its useful life. I believe that you, as our technical neighbors, will be interested in this initiative.

SHUTDOWN RISK

As previously mentioned, the continued safe operation of existing nuclear power plants is a requisite to any resurgence of the nuclear industry. In the past, regulatory activities focused primarily on transients and accidents during power operation.

More recently, international experience and preliminary studies have shown that risks during shutdown and low power operations should be assessed as to their contribution to total plant risk. The Nuclear Regulatory Commission has begun a study to quantify the risk at low power and shutdown conditions. Similar studies have been conducted in France. The NRC's review has been focusing on:

- reviewing and evaluating operating experience,
- developing insights from probabilistic safety assessments,
- visiting plant sites during outages to better understand shutdown operations,
- performing engineering studies to better understand accident sequences that could occur during shutdown,
- reviewing existing regulatory requirements governing shutdown and low power operations, and
- integrating information from all activities to develop a profile of risk during shutdown and low power operation.

In another international effort, the United States NRC and the regulatory agencies of France, Sweden, Germany, Spain, and Canada cooperated in the development of a report, "Regulatory Requirements and Experience Related to Low-Power and Shutdown Activities." The report was compiled for the Committee on Nuclear Regulatory Activities of the Organization for Economic Cooperation and Development (OECD) and included information from twelve participating countries. The topic of shutdown risk was the subject of a June 1991 specialist meeting of the Committee on Nuclear Regulatory Activities.

The NRC staff has identified the following five issues as especially important for shutdown operation:

- outage planning and control,
- stress on personnel and programs,
- the need for improvements in training and procedures,

- technical specifications, and
- PWR safety during mid-loop operation.

In addition, the staff identified the following topics as warranting further evaluations: loss of residual heat removal capability, containment capability, boron dilution events, fire protection, potential for draining the vessel, reporting requirements for shutdown conditions, and the inspection programs to address shutdown issues.

The NRC staff is scheduled to complete its formal regulatory analysis by the end of June 1992. The staff will then make a recommendation to the Commission on whether there is a need for any new requirements.

CONCLUSIONS

In the United States, there are many signs of a revitalization of the nuclear option. The NRC is responding to the challenges of thoroughly and efficiently carrying out its responsibilities of assuring adequate protection of the public.

I am pleased by the leadership the U.S. industry has taken in defining utility requirements to be used by the reactor vendors in developing new reactor design concepts. I am also pleased with the active participation by many of the Pacific Basin Members and other countries in working with the U.S. industry to ensure the broadest input in the development and safe operation of future nuclear power plants, and those of us who are regulators must be sure that we carry out our responsibility to review thoroughly the new designs, and their operation.

Nuclear technology has truly become an international technology. It recognizes no borders. I find it exciting and professionally rewarding to participate in an endeavor so important to the future economy of so many countries in an environment in which we openly and freely work together as technical neighbors.