GLOBAL COOPERATION ON NUCLEAR POWER PROJECTS

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ABSTRACT

Throughout the world today, expanding economies will dictate an increase in electrical energy. Over the next decade we will see different scenarios in the various regions of the world as countries begin to expand their generating capacities. Nuclear power is a proven, safe, economic, and environmentally friendly source of electric power that will continue to be a necessary part of the world's energy mix. Through cooperation with and among the nuclear generating countries, the benefits and responsibilities of choosing nuclear energy can be shared. Today we continue to find high activity worldwide on nuclear energy. Many countries have extensive programs focusing on nuclear electricity as a major element. For the West, particularly in the United States and Europe, the focus will be on improved operation and economics of existing nuclear plants. Plant safety upgrades and limited plant construction will be the main thrust in Eastern Europe and Russia. Significant new plant activity will occur in Asia, particularly in the Pacific Rim.

INTRODUCTION

Throughout the world today, expanding economies will dictate an increase in electrical energy. Worldwide power additions are expected to exceed 100 GWe per year for the next 15 years. This means that the total global electric power capacity orders will triple between now and 2007; from 500 GWe to 1500 GWe. Over the next decade we will see different scenarios in the various regions of the world as countries begin to expand their generating capacities. Westinghouse believes that nuclear power is a proven, safe, economic, and environmentally friendly source of electric power that will continue to be a necessary part of the world's energy mix. Through cooperation with and among the nuclear generating countries, the benefits and responsibilities of choosing nuclear energy can be shared.

KEY ELEMENTS

Safety should always be a key element of any power source, but it must be the single most important factor in the design and operation of a nuclear electric generating plant. The industry cannot survive another Three Mile Island, and the world will not tolerate another Chernobyl.

Economics is also a major factor in the outlook of nuclear energy in the world. No matter how safe a plant might be, it will not be built if it is not economical. Economics is the key to success in any world market. Without it, we cannot expect to succeed.

The importance of maintaining the environment for today's and tomorrow's generations has become a driving force in many industries over the last decade. The new focus comes from the ever-increasing knowledge concerning both the short- and long-term effect on the environment of contaminants that are harmful to humankind and their surroundings.

An example of efforts currently underway around the world is the reduction of CO_2 emissions from industrial processes that burn fossil fuels, thereby reducing the effect on global warming. We now know

almost certainly that the greenhouse effect will have consequences on the climate. These consequences will become considerable and will require strong responses to strategically react in a global manner, if we delay. The total amount of CO_2 emissions worldwide has already increased by over 50 percent over the past 20 years due mainly to fossil fuels. And the analyses of the World Energy Council point to a further substantial rise in these emissions in the next 30 years.

Based on studies by the Nuclear Energy Institute, generating one million kilowatt-hours of electricity produces about 150 metric tons of carbon from a gas-fired plant; 230 metric tons from a coal-fired plant; and 190 metric tons of carbon from an oil-fired plant. And, as you know, no carbon is produced by a nuclear plant.

In the United States, nuclear energy produces 22 percent of the electricity. By substituting for fossil fuels, nuclear plants reduced total U.S. CO_2 emissions by 147 million metric tons of carbon in 1996. Without nuclear energy, U.S. electric utility emissions of CO_2 would have been approximately 30 percent higher. In the long term, nuclear energy reduced total U.S. CO_2 emissions by two billion metric tons of carbon between 1973 and 1996, by not utilizing fossil fuels for electricity generation.

Worldwide, nuclear energy has significantly reduced greenhouse gas emissions. In 1993, 430 nuclear power plants in 29 countries produced about 17 percent of the world's electricity while reducing CO_2 emissions by eliminating 455 million metric tons of carbon. Between 1973 and 1993, approximately 5 billion metric tons of carbon were avoided through the total use of nuclear energy.

Today we continue to find high activity worldwide on nuclear energy. Many countries have extensive programs focusing on nuclear electricity as a major element. For the West, particularly in the United States and Europe, the focus will be on improved operation and economics of existing nuclear plants along with some pockets of interest for new plants in Hungary, Turkey, and Armenia. Plant safety upgrades and limited plant construction will be the main thrust in Eastern Europe and Russia. Significant new plant activity will occur in Asia, particularly in the Pacific Rim.

THE UNITED STATES

In the United States, political considerations, conservation, overall excess generating capacity, and abundant supply of low-priced fossil fuel make the consideration of new nuclear capacity unlikely for the next decade. Not withstanding this environment, U.S. utilities have been dedicated to keeping the nuclear option open without a clear prospect for building new plants and continue to support programs, such as the Westinghouse AP600.

As part of the cooperative U.S. Department of Energy (DOE) and the Electric Power Research Institute (EPRI) Advanced Light Water Reactor (ALWR) program, the Westinghouse AP600 team developed a simplified, safe, and economic 600 MWe plant to enter a new era of nuclear power generation. Designed to satisfy the standards set by DOE and defined in the ALWR Utility Design Requirements Document (URD), the Westinghouse AP600 includes a combination of innovative safety systems that rely on dependable natural forces and proven technologies. It is not the drive for passive plant that is important, it is the drive for simplicity. Simplicity brings both safety and economics.

The AP600 is currently being reviewed by the U.S. Nuclear Regulatory Commission (NRC) and is scheduled to receive final design approval in early 1998 and NRC certification in 1999. A detailed design program (First-of-a-Kind-Engineering) is proceeding in parallel with the NRC certification under the sponsorship of DOE, the Advanced Reactor Corporation (ARC), and EPRI. The ARC represents 16 U.S. utilities, and the AP600 team includes participants from 12 European and Asian countries. Development of this safe, simple and economic plant provides a model to serve as a standard plant in many countries of the world.

WESTERN EUROPE

The situation in Western Europe is similar to that of the United States with the main focus on improving performance and economics of existing nuclear plants. However, the European PWR is being developed to retain the technology and skills of nuclear plant design, with the decision to build the plant still to be made.

In addition, a group of European utilities, together with Westinghouse and its industrial partner GENESI (an Italian consortium including ANSALDO and Fiat), initiated a program in 1994 designated the European Passive Plant (EPP) to evaluate Westinghouse passive nuclear technology for application in Europe. The European utility group consisted of the following organizations: Agrupación electrica para al Desarrollo Technologico Nuclear (DTN), Spain; Electricité de France (EdF); ENEL, SpA., Italy; IVO Power Engineering, Ltd., Finland; Scottish Nuclear Limited (acting for itself and on behalf of Nuclear Electric plc), U.K.; Tractebel Energy Engineering, Belgium; UAK (represented by NOK-Beznau), Switzerland; and Vattenfall AB, Ringhals, Sweden. The EPP program involves evaluation of the Westinghouse 600 MWe AP600 and the 1000 MWe Simplified Pressurized Water Reactor designs against the European Utility Requirements (EUR), and when necessary, investigation of possible modifications to achieve compliance with the EUR.

In Phase 1 of the EPP program which was completed, the impacts of the EUR on the Westinghouse nuclear island design were evaluated and a 1000 MWe passive plant reference design was developed. Phase 2 of the program is focusing on improving the design detail of important systems and structures and performing the supporting analyses to produce a Standard Safety Analysis Report for submittal to European safety authorities. The EP1000 conforms to the EUR and is expected to be licensable in Europe.

CENTRAL AND EASTERN EUROPE

In Central and Eastern Europe, the focus is on plant safety upgrades with limited plant construction. Westinghouse is supplying instrumentation and control systems and fuel for the completion of the twin-unit Temelin Plant in the Czech Republic. Similar cooperative efforts can upgrade existing plants and bring new ones on line. There is also a need to shut down the RBMK plants and to replace them. However, the countries operating the RBMKs will not shut them down without some source of replacement power. Project financing will be the key element for replacement plants, and the market will be driven by whomever can arrange for financing. It may come to a point where the governments of the world will become concerned about having these plants operate. These replacements will be driven by safety concerns and not by energy needs.

Concerning project financing, the nature of the market may be changing in terms of how plants will be sold. In the past, nuclear companies first sold turnkey plants and then nuclear steam supply systems. Now companies are looking at Build-Own-Operate and Build-Own-Transfer plants in parts of the world. This will become more important in the future. An entity such as a utility or a government will want to buy power but not necessarily buy a plant. The contract would be based on the cost of electricity over a period of time. This may be the thrust of the next round of significant nuclear plant construction in some parts of the world where countries need power but do not have the means to finance it. They may necessarily want to own the plant, but have someone operate it and sell power to them.

ASIA AND THE PACIFIC RIM

As mentioned, the major growth of electrical generation in general, and nuclear in particular, will be in Asia and the Pacific Rim countries. Asian countries have the highest projected electricity growth – an increase of 88 percent between 1990 and 2010 at an annual rate of 3.2 percent. This includes a number of countries in the Pacific Rim with rapidly growing economies and strong industrialization programs, including South Korea, Indonesia, and India. These countries have experienced tremendous growth in

electricity consumption, and their governments have plans to continue meeting industrial and consumer demands.

South Korea is a leader in industrialization and electricity generation. Per capita generation of electricity is about 2,700 kWh. South Korea has had substantial growth in nuclear power generation over the past few years and now has 36 percent of its electricity generated by nuclear. Westinghouse was involved in supplying the first group of nuclear plants to Korea and continues to provide fuel products and plant services through joint arrangements. The use of nuclear power is expected to continue through 2010. In this case, a strategy to offset a concern about energy independence has led to significant environmental benefits.

Electricity generation grew about 15 percent annually in Indonesia during the 1980-1990 period, reflecting an accelerated expansion of capacity. Although coal's share is expected to dominate Indonesia's power mix, capacity expansion plans will consider the construction of nuclear plants in the long term.

In India, the annual growth rate in electricity demand is averaging about 8 to 10 percent in the 1990s. By not signing the international accords on nuclear nonproliferation, India has limited the potential for international involvement. India is counting on independent power producers to expand fossil electricity capacity to meet established targets.

Nuclear power continues to move ahead in Japan. Their energy needs are such that they do not want to build coal or oil plants since nuclear power provides both energy independence and a clean environment. General Electric, Hitachi, and Toshiba are building advanced boiling water reactors, and the first advanced pressurized water reactor (APWR) will be built in Japan. The APWR 1420 was developed through a joint design program involving Mitsubishi Heavy Industries, the Japanese utilities, the Ministry of International Trade and Industry (MITI), and Westinghouse. The APWR 1420 complies with all the top-tier ALWR URD requirements. The Japan Atomic Power Company will build two units at the Tsuruga site, and subsequent units are in the planning stage.

Another plant design derived from AP600 design fundamentals is the Simplified Pressurized Water Reactor (SPWR). The SPWR program was initiated in 1988 by Westinghouse and the Japanese utilities with support from EdF to examine higher megawatt applications of the passive technology.

China represents the world's largest market for new plants, and it is receiving the most attention. China has very large power needs with 50,000 MWe of installed nuclear capacity planned for 2020. This represents enormous growth considering they currently have 2100 MWe of installed nuclear capacity. China differs from other markets because it is very segmented. They do not have interconnections so you cannot build a plant in one part of the country and supply power to other parts. The provinces are almost like separate entities for power generation.

The need for power exists virtually everywhere. The largest growth area is Guangdong where two plants are operating and two more are under construction. It is an area that can accommodate larger plants in the 900 to 1000 MWe range. Most other areas cannot accept the larger plants so a need exists for smaller plants.

Westinghouse and its international partners are developing two plants for application in China; the CPWR 1000 and the CAP600. The CPWR 1000 is a 1000 MWe transition plant developed with the Sociedat Estatal De Participaciones Industriales (SEPI) in concert with the Shanghai Nuclear Energy Research Design Institute (SNERDI) and the East China Electric Power Design Institute (ECEPDI). The CPWR 1000 uses Vandellos 2 as an operating plant reference and meets key URD requirements.

The CAP600 is a 600 MWe advanced plant that is a derivative of the Westinghouse AP600 developed through international cooperation for application in China. In 1994, Westinghouse and the Nuclear Power Institute of China (NPIC) formed the CAP600 working group to develop the CAP600 design configuration

which combines features of the Qinshan Phase II 600 MWe plant, the AC600 developed by NPIC, and the Westinghouse AP600.

SUMMARY

Throughout the world, each country that is starting or continuing a nuclear program is focusing on state-of-the-art but advanced technologies for the 21st century. The technological advances are a logical sequence of changes being made for improvements in safety, operations, maintenance, construction, or simplicity that are linked together. They represent changes that should continuously occur to keep the plant designs up-to-date as we move into the 21st century.

The importance of advanced technology is to bring forward some of these elements of plant design that relate to improved plant performance and make them available to the major market for new plants, specifically in the Pacific Rim area. The focus on the APWR in Japan and the CPWR 1000 in China are the transition plants that bring many of the advanced technologies that have been proven and will ultimately be implemented in the AP600 technology.

In order for a country to have a successful nuclear program, it must eventually develop its own infrastructure. This is where nuclear generating countries can be of most assistance. Westinghouse's international nuclear programs are distinguished by a unique commitment to technology transfer. Helping other countries create solid nuclear infrastructures is the best assurance of expanding the use of nuclear energy worldwide.

Through global cooperation on nuclear power projects, countries can satisfy their increasing demands for energy with a source that is safe, economical, and friendly to the environment. Nuclear energy, conscientiously applied, meets all of these criteria.