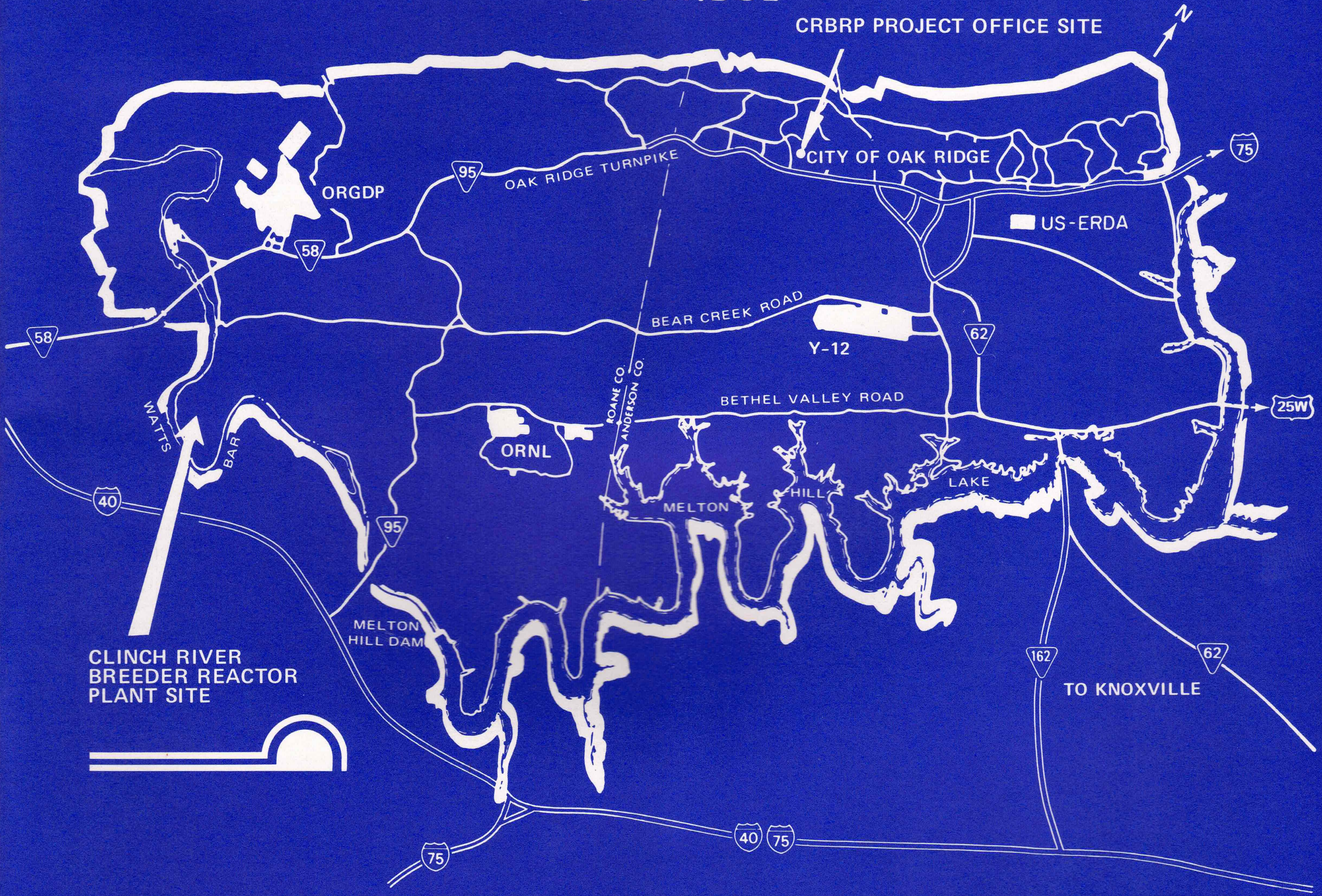
THE CLINCH RIVER BREEDER REACTOR PLANT AND ITS IMPACT ON THE ENVIRONMENT

SOME QUESTIONS AND ANSWERS

OAK RIDGE



THE CLINCH RIVER BREEDER REACTOR PLANT AND ITS IMPACT ON THE ENVIRONMENT

SOME QUESTIONS AND ANSWERS

TABLE OF CONTENTS

January 1977

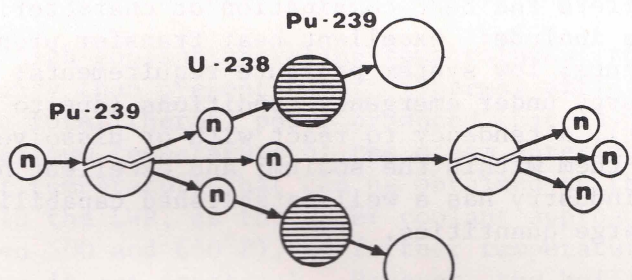
Published for the Breeder Reactor Corporation

U.S. Electric Systems Supporting The Clinch River Breeder Reactor Plant Project

I. THE LIQUID METAL FAST BREEDER REACTOR

Q. <u>What is a breeder reactor</u>?

A. A breeder reactor is a nuclear power plant which, like other power facilities, produces heat for generating electricity. Unlike any other power plant, however, the breeder also produces more new fuel than it uses as it operates. In a breeder reactor, uranium-238, the non-fissionable but more abundant part of natural uranium, is converted into plutonium-239, a man-made fissionable element which can be used as a reactor fuel. By utilizing the breeder concept, present uranium resources can be extended from decades to centuries, perhaps up to a thousand years.



This illustration symbolizes the fast breeder nuclear reaction. A "fast neutron" hits plutonium, simultaneously releasing energy to generate electricity and a number of free neutrons (n). Some neutrons split additional plutonium atoms, sustaining the chain reaction; while others are absorbed by "fertile" uranium-238, thus being converted into new plutonium-239.

Q. <u>Are there different types of breeder reactors</u>?

A. There are four principal alternate types of breeder reactors: the liquid metal fast breeder reactor (LMFBR), the light water breeder reactor (LWBR), the gas-cooled fast breeder reactor (GCFB), and the molten salt breeder reactor (MSBR).

The LMFBR is the choice for priority development by both the Energy Research and Development Administration (ERDA) and industry as the Nation's best nuclear option in terms of providing a new energy resource by the end of this century.

The LWBR in a practical sense is more of a converter than a breeder since it would not produce a large surplus of fuel for use in additional reactors. Thus, for an expanding LWBR system, substantial mining and enrichment of additional natural uranium would be required and this concept would ultimately be restricted by uranium availability.

The GCFB uses the same fuel cycle (uranium 238 conversion into plutonium) as the LMFBR and fuel utilization incentives are similar. The GCFB is presently behind the LMFBR in development, and considerable additional effort would be required to bring this reactor into a commercial operation on the same time scale as the LMFBR.

The MSBR operates on the thorium cycle and offers broader resource utilization. However, research and development requirements indicate that this reactor will not be available within the time scale necessary for the introduction of a breeder.

Q. Why is the LMFBR the U.S.'s choice of breeder for priority development?

A. Choice of the liquid metal fast breeder reactor (LMFBR) option for priority development by the U.S. breeder reactor program was based principally on predicted performance, industrial support, a broad base of technological experience, proven basic feasibility, and probability of development within the time frame required.

Use of liquid sodium offers the best combination of characteristics for the breeder reactor. These include: excellent heat transfer properties; low pumping power requirements; low system pressure requirements; the ability to absorb considerable energy under emergency conditions (due to its operation well below the boiling point); a tendency to react with or dissolve many fission products and to retain them within the sodium; and excellent neutronic properties. In addition, the U.S. industry has a well-established capability for producing high-grade sodium in large quantities.

Considerable technology, developmental efforts and operating experience previously acquired with sodium coolants contribute to the expectation that this reactor system can be developed to become a viable energy option in a relatively short period of time.

The technical concerns in the use of sodium—e.g., its potential for reaction with air or water—can be safely handled with existing technology.

Q. Why is the LMFBR needed?

A. Development of the LMFBR is considered the best option among the power generating technologies available to the utility industry before the end of the century. A major incentive for the development of breeder reactors is the potential for vastly improved utilization of uranium fuel resources. With the breeder, present uranium reserves can be extended from decades to centuries — perhaps up to 1000 years. Concurrently, however, the utility industry and the Federal Government are supporting work in other technologies to insure that all options are developed to the fullest extent to insure adequate power in the future.

The rapid growth of commercial Light Water Reactors (LWRs) over the past decade has clearly demonstrated that nuclear energy from LWRs is an economically competitive, reliable and safe source of electrical energy production. LWRs do not fully utilize the energy potential of the nuclear fuel, since they use only U-235 to provide one to two percent of the available energy in uranium but not U-238 (which cannot be fissioned economically). The breeder reactor, however, converts U-238 to fissionable Pu-239, increasing utilization of potential uranium fuel to as much as 60 percent.

Another key benefit is that the breeder will permit the United States to reduce its dependence on foreign energy sources. In addition, the development of the breeder would reduce the requirements for costly fuel-enrichment facilities and should enable substantial future benefits to accrue in terms of holding down electrical generation costs and environmental costs.

Q. What are the advantages of the LMFBR?

A. One major advantage of the breeder is its ability to convert otherwise worthless U-238 to fissionable Pu-239. Since more Pu-239 is produced than consumed, the breeder reactor is able to replenish its own fuel and can eventually provide enough additional Pu-239 to operate another reactor. Thus, with the introduction of the breeder comes the ability to economically use not only low-grade uranium ore, but also the depleted uranium produced as a by-product of the LWR fuel cycle, thereby reducing future uranium mining requirements.

Because of the high coolant operating temperatures, the breeder has a higher thermal efficiency than present LWRs. (Thermal efficiency is defined as that fraction of the total thermal power produced that is converted to electrical power.) The maximum temperature of the steam entering the turbine is set by the maximum coolant temperature that can be obtained as the coolant passes through the reactor. In the LWR, as the water coolant approaches the boiling point (usually between 500 and 650°F), no further temperature increase can take place and superheating is not practical. However, the boiling point of sodium is much higher (approximately 1,650°F) and direct sodium superheating of steam is possible. Thus, an LMFBR plant of equivalent thermal power to an LWR plant produces a higher net electrical output.

The breeder, as well as nuclear power plants in general, offers distinct environmental advantages over fossil-fuel power plants, such as no fly ash or sulfur dioxide emissions. Impacts on the environment due to mining and transportation of large amounts of fossil fuel would be eliminated, and these fossil resouces could then be used for other non-energy uses. A less obvious benefit, brought about by the decrease in mining and fabrication requirements, is the reduction in occupational accidents.

Any release of radioactive effluents to the environment is expected to be less than the release from presently operating power plants and will be well within applicable regulations. In addition, waste heat discharged to the environment will be less for the LMFBR than for presently operating plants because of the increased thermal efficiency.

Q. Are there particular factors for the LMFBR which require special safety considerations?

A. Yes. The LMFBR has a number of important inherent safety advantages relative to other systems, but it also incorporates factors which require special attention. Sodium and plutonium are the most notable examples.

Sodium, which serves as the LMFBR coolant and heat transfer agent, and plutonium, the fast breeder reactor fuel, are two factors which distinguish the LMFBR from other nuclear reactor systems. Both are well understood from a technical viewpoint, and full consideration is given in the plant design to utilizing the unique advantages of each while fully recognizing and reflecting appropriate requirements for safety and environmental protection.

It is important to note that working with these materials is not a new experience. Atomic workers have been handling plutonium safely for about 30 years and during that time very effective precautions including facility designs and handling techniques have been developed to minimize the health hazards associated with plutonium. In fact, much more is known about the toxicology of plutonium than is known about most other hazardous elements. There has never been a known death attributable to the toxicological properties of plutonium. The United States has many years of industrial experience in safely handling sodium.

Q. Why should the LMFBR program proceed expeditiously?

A. Present projected demands for uranium to fuel light water reactors and high temperature gas-cooled reactors indicate that the low cost uranium reserves would be committed by the end of the century for the lifetime operating requirements of existing reactors. Separative work requirements would increase and the costs of refined U_3O_8 would increase sharply (from \$3 per pound to approximately \$100 per pound by the year 2020). Timely introduction of the LMFBR would significantly reduce uranium ore requirements (mining), uranium ore costs and separative work requirements and, as a consequence, would reduce electric energy cost increases.

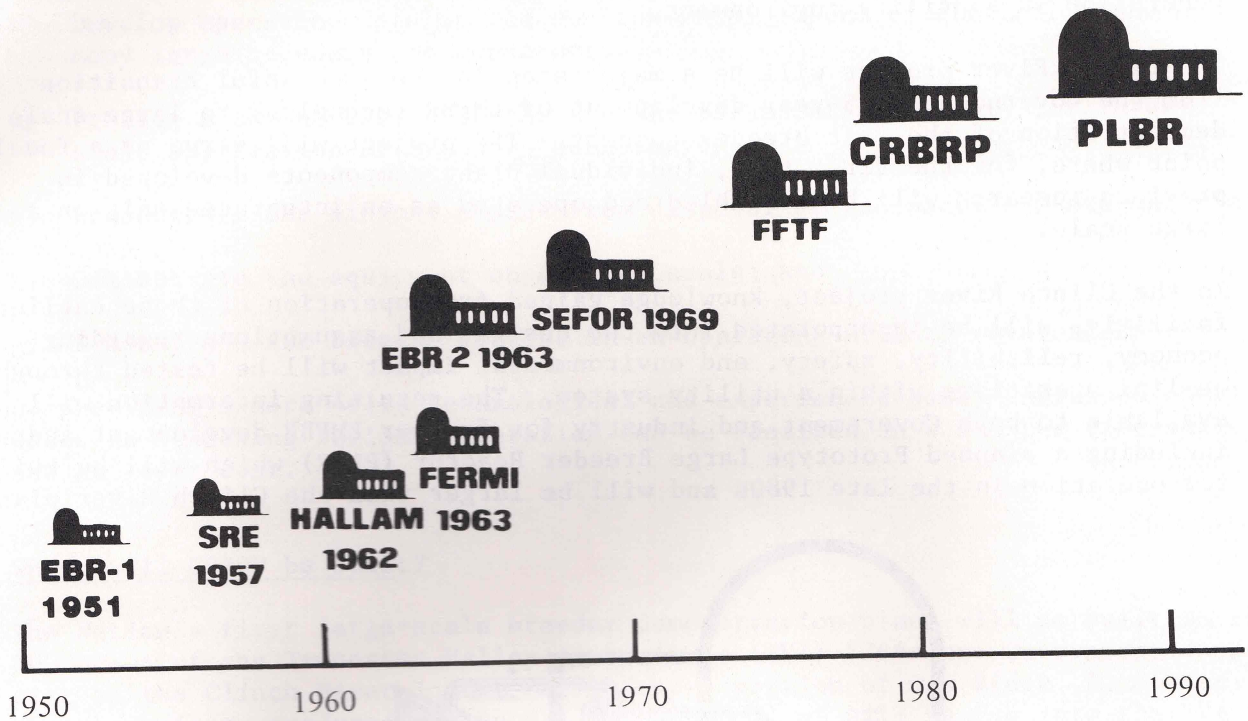
In addition, unless the breeder is developed, generating capacity demand must be met with other energy producing systems such as LWRs or fossil-fuel power plants. Meeting this demand with additional LWRs would increase uranium ore requirements, thereby increasing the depletion rate of the known uranium resources. Additional LWRs would also increase the total thermal discharge to water bodies relative to the LMFBR.

The accelerated use of fossil-fuel plants would of course increase the demand for coal or oil. Some of this will be necessary in any event, but reliance on coal without nuclear power would commit too much land for mining and would add to the pollution problems by releasing more undesirable stack emissions. This would lead to higher costs for development and construction of pollution control equipment. Low reserves and the increasing cost of oil, along with the substantial risks associated with a reliable supply, do not make oil-fueled power plants a desirable alternative.

Q. What are the major steps that have been taken in the development of the LMFBR?

A. Breeder reactors have been under development in this country since the early days of the atomic energy program. The first electricity from a nuclear reactor was produced by an experimental breeder reactor (EBR-1) on December 20, 1951. EBR-1 was followed by EBR-2 which tested fuels and materials while demonstrating on-line reliability and power generation. Other breeder projects included the Enrico Fermi Atomic Power Plant No. 1, which provided insight into developments needed for larger breeder plants, and Southwest Experimental Fast Oxide Reactor

(SEFOR), which proved out some inherent safety characteristics of the LMFBR. Important testing of fuels and components for liquid metal fast breeder reactors will be accomplished at the Fast Flux Test Facility (FFTF) under construction at Hanford, Washington. The logical and essential next step in LMFBR development is the Clinch River Breeder Reactor Plant.



Steps in breeder development as part of U.S. civilian nuclear power program.

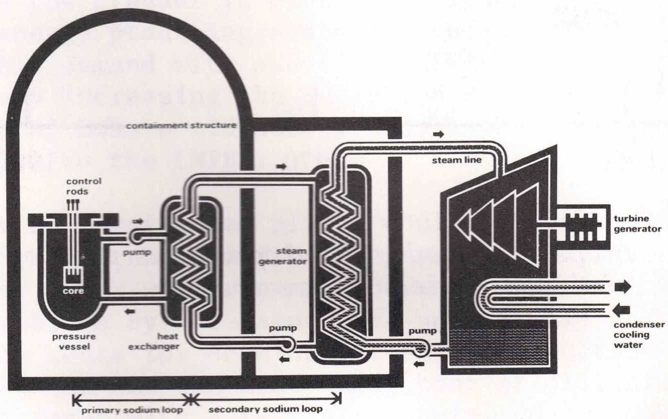
II. THE CLINCH RIVER BREEDER REACTOR PLANT PROJECT

Q. <u>What is the Clinch River Breeder Reactor Plant (CRBRP) Project</u>?

A. The Clinch River Breeder Reactor Plant (CRBRP) Project is the joint Government and industry effort to build the Nation's first large-scale (350-400 megawatt electrical) demonstration breeder nuclear power plant. CRBRP is designed to demonstrate the commercial potential and environmental advantages of a large-scale liquid metal fast breeder reactor (LMFBR) as a source of electrical generation in a utility environment.

The Clinch River project will be a major step in the successful transition from the Government's 25-year development of LMFBR technology to large-scale demonstration of the fast breeder concept. The project will serve as a focal point where, for the first time, individual plant components developed in previous research will be assembled and operated as an integrated unit on a large scale.

In the Clinch River project, knowledge gained from operation of these earlier facilities will be incorporated into the design; and assumptions regarding economy, reliability, safety, and environmental impact will be tested through on-line operations within a utility system. The resulting information will be available to both Government and industry for further LMFBR development and use including a planned Prototype Large Breeder Reactor (PLBR) which will be built for operation in the late 1980s and will be larger than the Clinch River plant.



Schematic outline of Clinch River Breeder Reactor Plant systems.

Q. <u>Why is the demonstration project needed</u>?

A. Over the past quarter of a century, the United States has constructed a number of test facilities to show the actual performance and interrelation of important technological, engineering, operational and economical factors. As the next logical step in the breeder reactor program, the capability of the LMFBR as a safe, power-producing facility must be demonstrated.

More specifically, the CRBRP will help the utility industry and the Energy Research and Development Administration in the following ways:

a) Demonstrate that the necessary technology is indeed available to scale up and successfully construct and operate larger, economical breeders;

b) Provide a technical basis for extending the technology to future commercial plants where improvements in fuel life, plant capacity and thermal efficiency will be made for economic reasons;

c) Develop operating data on the environmental impact of the LMFBR before many large breeders are constructed;

d) Provide a demonstration of the nuclear parameters necessary for large-scale application of breeder technology;

e) Demonstrate the minimal impact from disposal of radioactive waste materials;

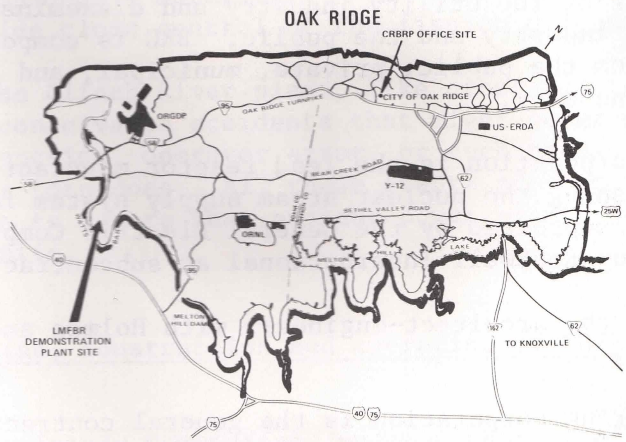
f) Demonstrate the equipment on a large scale; and

g) Demonstrate the breeder concept in an operating utility environment.

By providing a more solid technological and experienced base, increased confidence in achieving reliable operation can be realized on a shorter time scale and at lower cost.

Q. <u>Where will CRBRP be built?</u>

A. The Nation's first large-scale breeder demonstration plant will be built on about 100 acres of the Tennessee Valley Authority's (TVA) 1364-acre Government-owned site on the Clinch River in the Roane County portion of Oak Ridge, Tennessee. The electricity produced by the demonstration plant will be fed into the TVA power grid. More detailed information about the site is in the next chapter.



Map of Oak Ridge, with locations of the liquid metal fast breeder reactor (LMFBR) demonstration plant (left) and principal ERDA facilities.

Q. How much will the CRBRP Project cost?

A. Based on the approved reference design, with initial plant operation in 1983, total project cost is estimated at $1.950 billion, which includes funds for construction, research and development, as well as operation during the five-year post-construction demonstration period. Sponsoring utilities are furnishing more than $257 million — the largest industry commitment ever made for a single energy research and development project. The Federal Government is to provide the remainder of the funds.

Q. What is the schedule for completion of CRBRP?

A. Initial clearing, grading, and excavation of the site are expected to begin in 1977 under a Limited Work Authorization requested from the Nuclear Regulatory Commission (NRC). Major construction is expected to start in 1978 with a target date for initial startup in 1983. This will be followed by a five-year period of "demonstration" operation.

Q. Who are the key participants in CRBRP?

A. The U.S. Energy Research and Development Administration has lead responsibility for managing the Clinch River Breeder Reactor Plant Project. Management is carried out by a single integrated organization composed of both Government and industry personnel, including representatives of the major project partners — ERDA, the Tennessee Valley Authority, and Commonwealth Edison Company of Chicago. The Project Office has been established in Oak Ridge, Tennessee.

Project Management Corporation (PMC), a non-profit organization formed especially for the Clinch River project, represents the utility industry in the project. PMC is responsible for project monitoring, utility fund management, preparation of information, and arranging participation by utility personnel in the program.

A second non-profit group, the Breeder Reactor Corporation (BRC), provides senior counsel on behalf of the utility industry and disseminates information to both the electric power industry and the public. BRC is composed of more than 740 electric systems from the public, private, municipal, and cooperative sectors of the electric power industry.

Westinghouse Electric Corporation is the lead reactor manufacturer, responsible for designing and furnishing the nuclear steam supply system for the Clinch River plant. Westinghouse is supported by the General Electric Company and the Atomics International Division of Rockwell International as subcontractors.

Burns and Roe, Inc., is the architect-engineer, with Holmes and Narver, Inc., as a subcontractor.

Stone & Webster Engineering Corporation is the general contractor for constructing the Clinch River plant.

Q. How many persons are working or will be employed on the CRBRP Project?

A. Nationally some 1800 scientists, engineers, and administrative personnel from participating Government and industrial-contractor organizations are engaged in the plant design and supporting research and development.

Locally in Tennessee about 350 are working in the Project Office at Oak Ridge. Some 2400 construction workers are expected to be employed on the Clinch River project during the peak construction period between 1979 and 1982. Most of these will be hired from the local area. Over $300 million in payroll will flow into the local economy through the project demonstration phase (about 1988). A permanent staff of approximately 180 employees will operate the plant in the 1980's. The annual payroll will be over $4 million.

Q. What is the safety philosophy behind CRBRP?

A. The Clinch River plant is being designed and built in accordance with the U.S. nuclear industry's three-level "defense-in-depth" safety concept which provides multiple and redundant systems to minimize the possibility and consequences of all types of abnormal occurrences.

The first level provides a sound and reliable functional design based on proven technology. The second level recognizes that some minor malfunctions will occur and protects against these anticipated faults with a comprehensive and reliable protection system. The third level takes into account extremely unlikely accidents which are never expected to occur during the lifetime of the plant and takes measures to prevent or mitigate the consequences of these unlikely events.

A breeder reactor (or any other type of nuclear reactor) cannot explode like an atomic bomb since the reactor does not contain the proper ingredients or configuration for such an explosion. A nuclear reactor uses very stable dilute fuel in the form of an unburnable oxide, whereas a nuclear bomb requires almost 100 percent fissionable material. Power reactors also have control and safety rods that provide close control of the fission process.

In addition, the Clinch River plant, like other reactors, will be designed to withstand all conceivable accidents that might occur whether they result from equipment malfunction, operator error, or such natural phenomena as floods, earthquakes, or tornadoes. All these events are carefully examined and factored into the design to assure that nuclear power plants do not represent any undue risk to the public.

Q. How is the design, construction and operation of CRBRP being licensed and regulated?

A. The Nuclear Regulatory Commission, under authority of the Atomic Energy Act of 1954, as amended, and the Energy Reorganization Act of 1974, has licensing and regulatory authority over the design, construction and operation of the CRBRP. This will require meeting the same Federal regulations that apply to all commercial nuclear power facilities. This includes preparation of a comprehensive

Environmental Report and Preliminary Safety Analysis Report which serve as the basis for extensive reviews of the safety and environmental aspects of the plant by both the NRC and other state and Federal agencies before construction can begin. The licensing process provides for public participation in hearings conducted by qualified experts who compose the Atomic Safety and Licensing Board. In addition, all documents and other material in support of the construction permit application are available for review by the public. Later, a Final Safety Analysis Report must be prepared and approved by NRC before operation will be permitted.

III. CRBRP ENVIRONMENTAL REPORT DATA

Q. What is the best source of information about the environmental impact of the Clinch River plant?

A. This booklet summarizes basic information of interest to the general public about the site and environmental impact of CRBRP. The best sources for detailed information are the CRBRP Environmental Report prepared by project participants, and the Final Environmental Statement on CRBRP prepared by the Nuclear Regulatory Commission (NRC).

Copies of the full Environmental Report and the Final Environmental Statement are available in the Oak Ridge and Knoxville, Tennessee, public libraries and NRC's public document room in Washington, D.C. The Project Information Division at Oak Ridge will assist in providing detailed information.

Q. Who prepared the CRBRP Environmental Report and why was it done?

A. The Clinch River Breeder Reactor Plant Environmental Report was prepared by the Westinghouse Environmental Systems Department (WESD) under contract to Project Management Corporation. Some sections were written by various WESD department members with expertise in meteorology, health physics, engineering, biology, and other technical disciplines. Other sections of the report were written by the Tennessee Valley Authority; the Reactor Research and Development Division of the U.S. Energy Research and Development Administration; Burns and Roe, Incorporated (architect-engineers); the Advanced Reactor Division of Westinghouse (reactor manufacturer); and PMC.

An environmental report for a nuclear power plant provides information required by the Nuclear Regulatory Commission, the Federal agency which has regulatory responsibility for the nuclear industry, to aid in assessing the potential environmental effects of the plant to assure that the issuance of the Construction Permit and Operating License will be consistent with environmental goals set by the National Environmental Policy Act of 1969. The CRBRP Environmental Report describes the plant and its systems, the area in which the plant will be built, and the existing environmental factors or conditions that could be affected by plant construction and operation. Based on this background information, projections have been made about the environmental impacts that may be associated with construction and operation of the CRBRP. Also included in the report are discussions of alternative plant systems and the cost-benefit information which support the need and timing for the plant.

A. THE SITE

Q. Where is the CRBRP site?

A. The Clinch River site is in east central Tennessee, in the eastern part of Roane County and within the city limits of Oak Ridge, Tennessee. Knoxville, Tennessee, is approximately 21 miles east-northeast of the site. Other cities within a 10-mile radius of the CRBRP are Lenoir City, about 8.5 miles southeast; Kingston, 7 miles west; and Harriman, 9.5 miles west-northwest.

The site is on a peninsula formed by a meander of the Clinch River between approximately river miles 15 and 18. The northern end of the peninsula is bounded by ERDA's Oak Ridge Reservation. Although the site is technically within the city limits of Oak Ridge, it is located in the southwestern section on undeveloped property which is owned by the U.S. Government. The 100 acre portion of the 1364-acre site required for CRBRP will be transferred from TVA to ERDA control. The remainder of the site will remain in TVA custody.

Q. Were alternate sites considered?

A. In arriving at the specific site selection for the LMFBR demonstration plant on the TVA grid, TVA carried out screening studies on all existing TVA plants in the region and on eleven potential new sites. As a result of the screening studies, extensive engineering, environmental and economic studies were made by TVA, Commonwealth Edison, and the former Atomic Energy Commission (now ERDA) for two hook-on alternative sites (John Sevier and Widows Creek) and a new site on the Clinch River.

The three principal candidate sites, John Sevier, Widows Creek and Clinch River, were studied and compared. Major points of comparison included site location, access, population, geology, seismology, hydrology, flood features, meteorology, land and land use, ecology, public water supplies, historic sites and economical factors. The advantages or disadvantages of a hook-on plant versus an all-new site and plant were considered.

In addition to the above comparisons, several other important factors were considered in selecting the site for the CRBRP. These factors were design flexibility, non-reimbursable costs to TVA (loss of capacity and replacement energy cost when the units were shut down for tie-in), potential value of the plant at the end of the demonstration period and potential technical difficulties associated with a hook-on arrangement.

Q. Why was the Clinch River site chosen?

A. An analysis of the site characteristics and environmental factors identified no major problem which would preclude the use of John Sevier, Widows Creek or Clinch River sites for the CRBRP.

The engineering feasibility studies were favorable for all three sites. However, the added control complexibility associated with the hook-on plant could reduce plant availability. There was uncertainty associated with application of nuclear standards and quality assurance requirements to the turbine plant and related facilities for the hook-ons. Also because of the mismatch in steam conditions for the hook-on alternatives, they were less desirable from the standpoint of optimum plant performance. The John Sevier units operate on a reheat cycle which adds to plant capital and operating costs. Moreover, the planned experimental activities at Widows Creek coupled with LMFBR construction activites could compound station availability problems there. Considering these factors, the Clinch River site, with an entirely new plant, could have an availability advantage.

The sites were considered to be about equivalent from an economic standpoint. The new plant at the Clinch River site, as opposed to the sites involving the hook-on concept, has a better chance of being of value to the TVA power system as a generating source after the initial five-year demonstration period.

Based on these considerations and the advantages of the new plant concept in offering greater flexibility in the Nuclear Steam Supply System design to meet program objectives and less chance of interruption or adverse effect on the operation of the TVA power system, the Clinch River site was selected as the best overall site of those considered for developing the Nation's first LMFBR demonstration plant.

Q. <u>What is the area like?</u>

A. Virtually all of the area within 50 miles of the Clinch River site is within Tennessee. Only a small portion of North Carolina and a very small portion of Kentucky are included. The population within this 50-mile radius was estimated to be 678,800 in 1970 for a population density of 86.5 people per square mile.

Numerous small communities and crossroads settlements are scattered throughout the region and are surrounded by low density rural development. Within 5 miles of the site there are no significant concentrations, only a few farms and residences on the southern side of the Clinch River. Approximately one-third of the area within the 5-mile radius is in either ERDA or TVA custody.

Two major industrial activities within the 5-mile radius are the Oak Ridge Gaseous Diffusion Plant and the Oak Ridge National Laboratory. One small nuclear-related industry is located in the Clinch River Consolidated Industrial Park at the northern boundary of the site. Within 10 miles of the site are the Kingston Steam Plant and the Federal Government's Y-12 Plant.

No major sport facilties exist within 10 miles of the site. There are two camping sites in the area and several bank fishing spots. A small stock-car racetrack is located about 3 miles east-southeast of the plant site.

Steep limestone ridges, hills and knobs are characteristics of the region. The Clinch River is part of the TVA system and as such, is a "controlled" river. Melton Hill and Norris Dams are located approximately 5 miles and 60 miles, respectively, upriver from the site; and Watts Bar Dam is on the Tennessee River approximately 55 miles downstream from the site.

The site itself is an uninhabited, heavily wooded area. Numerous species of plants and animals have been found in the area but no endangered species are in the proposed plant site area.

Q. <u>What studies have been done to demonstrate site suitability?</u>

A. A geological survey consisting of over 100 borings was done on the site as part of the foundation investigations. Other geological studies included a detailed literature review, surface mapping, remote sensing, seismic refraction and related geophysical surveys.

Meteorological data are being collected from a 200-foot tower erected on the site in order to obtain accurate information on local meteorological conditions. This is important because of the valleys and ridges in the area. Conditions in one valley may be totally different than conditions in the next valley; therefore, on-site data are essential.

Aquatic and terrestrial surveys have been conducted on the site to give an accurate account of existing plant and animal species. This baseline information has been used to project environmental impacts expected from CRBRP construction and operation.

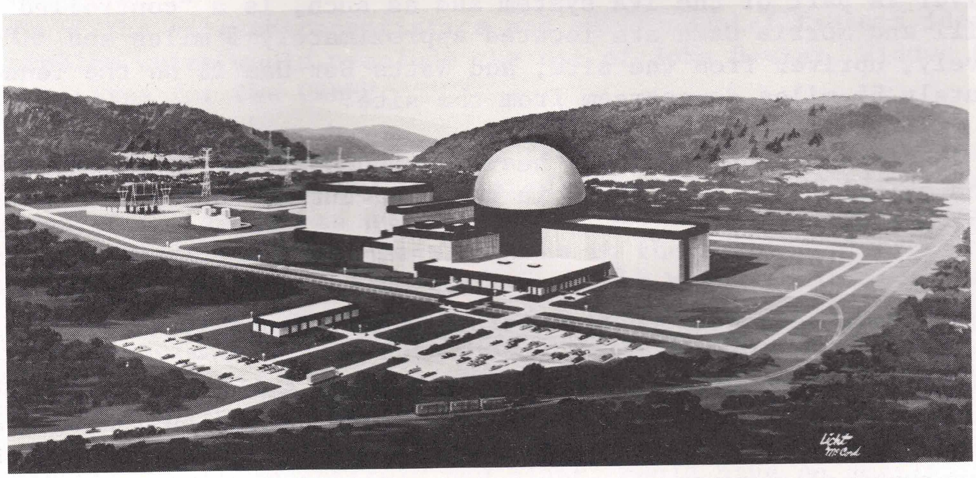
Site investigations were conducted to ensure that construction or operation of the plant would not damage or destroy any significant historical or archaeological areas.

Surveys and analyses have been made so that socio-economic impacts from the plant can be assessed and projections made.

B. THE PLANT

Q. <u>What will plant aesthetics be in relation to its surroundings?</u>

A. The CRBRP will blend in well with its surroundings. All exterior colors will blend with the surrounding environment. The cooling towers will be painted in cool, light colors with accent colors used for exposed piping, stairs or other major appurtenances. Site landscaping will be limited primarily to grassed areas with some low growing shrubs used sparingly around the entrance for decorative purposes. Buildings in the CRBRP complex will be of steel-frame or "poured-in-place" concrete construction. The steel-frame buildings will be enclosed with fluted metal curtain walls and will have wide roof fascias proportioned to the scale of the buildings. Concrete buildings will have a textured finish enhanced by horizontal bands.



Artist's conception of Clinch River Breeder Reactor Plant

Q. What will the CRBRP consist of?

A. The CRBRP will be an integrated single-unit electric power plant and will consist of a liquid sodium cooled reactor, a steam generation system, a steam turbine-driven electric generation system, a heat rejection system, radwaste systems, transmission facilities and other related auxiliary systems, supporting structures and facilities.

The reactor of the CRBRP will consist of a core zone where most of the heat will be produced. Surrounding the core will be radial and axial blankets where Pu-239 will be "bred" from U-238. In the steam generation system, three parallel primary and intermediate heat transport loops will be used. Sodium coolant in the primary loops will remove heat from the reactor. Heat in these primary sodium loops will then be transferred to sodium in the three intermediate loops which circulate through the steam generators where feedwater will be converted to steam to drive the turbines.

The heat rejection system will consist of a water intake system, cooling tower and discharge systems. Other plant systems will include a chemical waste system, biocide system, sanitary waste system and the radwaste systems.

Other related or supporting facilities will include transmission facilities such as switchyards and transmission lines, service buildings and warehouses.

Q. Why was the basic reference design selected?

A. Alternate designs were considered for each of the major plant systems with potential to impact the environment. Choice of the selected system in each case was based upon an evaluation of environmental and economical factors, and other factors or costs.

In considering the cooling system for example, seven alternative systems (i.e., spray ponds, cooling lake, natural draft tower, etc.) were taken into consideration. The selected cooling system for the CRBRP is the mechanical draft wet tower. This system will provide significant protection from adverse environmental effects of thermal discharges and is economically preferable to and environmentally competitive with other recirculating mode cooling systems.

The perforated pipe was selected from among nine alternative systems for the intake. It offers the advantages of a simple design that eliminates the need for costly trash rakes and traveling screens, a unique internal sleeve modification to produce very desirable approach velocity characteristics that provide significant protection against fish impingement, a small enclosed shoreline structure that reduces the aesthetic impact and no debris disposal requirements.

Three alternatives were considered for the discharge system and the high momentum submerged single port discharge was selected. It provides a high degree of mixing effectiveness under different river conditions and ensures a rapid reduction in blowdown excess temperature and an adequate dilution of chemical effluents. Selections of the chemical waste system, the biocide system, sanitary waste system, the radwaste systems and other plant systems were made in the same manner — all reasonable alternatives were evaluated and the system which was considered to best fulfill the environmental and economical cost requirements was selected.

Q. <u>What type of fuel will be used in the CRBRP</u>?

A. A core fuel assembly is composed of 217 stainless steel rods arranged in a triangular pitch and supported in a hexagonal metal duct. Longitudinally, each rod consists of an active fuel region, axial blankets on the top and bottom of this core and a fission gas plenum. Fuel for the core consists of oxides of plutonium and either depleted or natural uranium sintered into pellets and encapsulated in the rods. The upper and lower axial blanket sections contain natural or depleted uranium in oxide form which is bred into plutonium during plant operation.

A radial blanket assembly is composed of 61 stainless steel rods arrayed in a triangular pitch and supported in a hexagonal metal duct similar to that of the fuel assembly. Longitudinally, each rod consists of a blanket region and an associated fission gas plenum. The fertile material in the blanket region is depleted uranium oxide sintered into pellets and encapsulated in the stainless steel rods.

C. CONSTRUCTION AND OPERATION

Q. <u>Will construction and operation of the CRBRP have an adverse effect on any historic, scenic, cultural or national landmarks</u>?

A. Investigations conducted throughout the CRBRP site have revealed no significant scenic or natural landmarks and no historical structures or sites that would qualify for inclusion in the National Register. The only site of local historical interest is the Hensley Cemetery consisting of five graves. Relocation of the graves will not be required because the cemetery is located on the southern tip of the peninsula, beyond the construction limits of the CRBRP. The Hensley family descendants will retain the right of access to visit and maintain the cemetery.

Several archaeological sites were located, excavated in depth and the materials or artifacts removed for further detailed laboratory analyses. Power lines which currently traverse the site and proposed transmission lines for the CRBRP do not and will not pass through any area of known significance. Therefore, construction and operation of the CRBRP will have no adverse effect on historical scenic, cultural or natural landmarks.

Q. <u>Will the CRBRP affect local weather conditions</u>?

A. Some minor influence on local meteorology may be exerted by the plant. Because the plant area will be cleared of trees, leveled, graded and black-topped in some areas and buildings will be erected, it will change the reflective power of the earth in this particular area and produce a small local heat island. The effect on temperature in the plant area would be in the range of about two degrees Fahrenheit or barely discernable unless measured.

Evaporation of water into the atmosphere from the cooling tower will form a visible vapor plume in a humid or very cold atmosphere. The plume may, at times, diffuse to ground level forming fog or cause rime ice to form on vertical structures or roads in freezing weather.

However, in comparison to the extent of natural fogging or icing in the area, the additional amount caused by the cooling tower will be insignificant. No other effects on local weather conditions are expected to be caused by the CRBRP.

Q. <u>What effect will the CRBRP have on the plant and animal life in the area?</u>

A. The most significant effects of the CRBRP on the terrestrial ecology of the area will occur in connection with site-preparation and construction activities. All trees in the construction area will be cut and the area will be leveled, graded and excavated. No rare or endangered species were observed in this area.

Larger animals, such as the white tailed deer, have sufficient nearby habitat to use and will not be affected by habitat loss. However, smaller animals (i.e., the eastern cottontail or the short-tail shrew), some birds and some snakes may be reduced slightly in numbers due to loss of habitat.

Increased human activity and construction noise will have only minor effects on mammals, herpetofauna or birds. Many of these species actively move about and feed only in the early morning or late evening when construction activity usually does not occur. Some mammals may vacate the area until construction is finished.

Operation of the plant will have less effect than construction activities on the terrestrial ecology. Disturbed areas around the perimeter of the plant will be reseeded and trees planted. Fauna will gradually return to utilize these areas.

Construction of the intake and discharge structures and the barge unloading facility will affect various forms of aquatic life and benthic habitats for a short duration. Every precaution will be taken (for example, coffer dams or riprap construction) to keep siltation and turbidity to a minimum.

During plant operation, the only environmental impact on aquatic life will come from the thermal discharge. However, this impact will not be significant. Fish migrations will not be impeded and spawning habits should not be disrupted because the thermal plume which will result from cooling tower blowdown is relatively small when compared to the total cross-sectional area of the river at the point of discharge. Results of thermal plume studies indicate that the plume will be relatively small and have a low increase of temperature over the ambient river temperature. Therefore, it is concluded that aquatic life in the Clinch River would not be seriously affected by the thermal effluent from the plant.

Q. <u>How will operation of the CRBRP affect the groundwater and Clinch River water?</u>

A. The CRBRP is designed so that <u>none</u> of the factors which conceivably could affect the groundwater will do so. These factors which are protected against by the CRBRP design include (a) contamination from liquid or solid wastes; (b) seepage from contaminated bodies of surface water; (c) deposition from cooling tower drift; (d) accidental leakage from storage facilities of chemicals and fuels; and (e) depletion of the water source by over-withdrawal.

No liquid or solid waste disposal areas will exist on the site. The sanitary system will have no contact with the ground, and sludge from the system will be trucked off-site for disposal. Recharge to the aquifers is through surface soils and fractures, faults and folds in the strata. Discharge from the aquifers is through streams into the Clinch River which is a groundwater sink. Cooling tower drift will not contaminate the soils in the area; therefore, they will have no effect on the groundwater. Storage facilities for chemicals, fuels and oil will be constructed with catch basins to prevent leakage to the soils. The plant will not use groundwater for any purposes. Thus, the operation of the CRBRP is not expected to have any effect on the quality or quantity of the local groundwater.

Blowdown from several plant streams, such as the chemical and biocide system and the sanitary system, is combined with the cooling tower blowdown before discharge to the Clinch River. To minimize possible effects from the CRBRP on the river ecosystem, the cooling tower was designed to discharge a blowdown that will contain only a 2.5 fold concentration of the chemicals already present in the Clinch River. The CRBRP will use no corrosion inhibitors in the circulating water and only trace amounts of iron, chromium and nickel are expected in the discharge. Chlorine will be used in the plant as a biocide; however, blowdown will automatically be shut off if the average concentration in the blowdown exceeds 0.2mg/l and will not be started again until the concentration of chlorine is under this limit. Since all discharge effluents will be constantly monitored to ensure that they are within applicable State and Federal standards, no significant adverse impact is expected on the Clinch River.

Q. <u>How will the gaseous, liquid and solid wastes be handled?</u>

A. Volatile radwaste gases processed by the gaseous radwaste system consist of noble gas radionuclides and tritium generated by fission and/or neutron activation. The general gas-processing method involves three processes: (a) most of the noble gas radionuclides are short-lived and are removed by natural radioactive decay during the extended holdup of the gas in tanks and in the charcoal delay beds; (b) the long-lived Krypton-85 is concentrated and collected in solution in liquid argon, which is periodically drained, evaporated and bottled for disposal; and (c) gaseous tritium is oxidized and collected in a dryer and periodically drained for disposal as tritiated water.

The general processing system involves two subsystems; the radioactive argon processing system (RAPS) and the cell atmosphere processing system (CAPS). RAPS is a closed decontaminating and recycling system for controlling the radioactivity in the reactor and primary heat transfer system cover gas. The small amount of leakage that does occur from the cover-gas/recycle-gas system is almost completely contained within cells where the atmosphere is diverted to CAPS for processing. In CAPS, the collected leakage gases are processed to remove xenon, krypton and tritium, so that the purified gases may be safely discharged to the Reactor Service Building heating and ventilating system for release.

The liquid radwaste system is designed to process liquid radwaste so that the majority of the activity is contained in solid material, to be loaded into containers and transferred to a U.S. Government-licensed contractor for processing and burial. Two subsystems make up the liquid radwaste system. The first subsystem is designed to process liquids with intermediate levels of radioactivity that are reused after decontamination, and the second subsystem is designed to process liquids with low levels of radioactivity that are released, after decontamination, into a dilution stream. Decontamination of liquids with intermediate or low level activities is carried out in the following sequence: liquids are collected and then processed through one or more cycles of filtration, evaporation and demineralization. Condensate from an evaporator is pumped to a storage or monitoring tank prior to reuse or discharge. When the decontaminization process is completed, the concentrated liquid radwaste will be collected from the bottom of the evaporators and transferred to the solid radwaste system.

The solid radwaste system is designed to handle five types of wastes; concentrated liquids, compactible solids, non-compactible solids, metallic sodium and sodium bearing components. Concentrated liquids are mixed in drums with cement and additives, which aid in the curing, are capped and sealed. The sealed drum is then inverted, vibrated, re-inverted, decontaminated by rinsing, monitored, stored temporarily and then transferred to a licensed contractor for disposal. Compactible solids such as rags, paper and rubber seals will be placed in drums and compacted by a hydraulic compacting machine. The low-activity non-compactible solids will be placed in drums, capped, decontaminated, monitored and placed into temporary storage. Radioactive sodium will be transferred to the solid radwaste system in drums and placed in storage. All these drums from the solid radwaste system will be transferred to a licensed contractor for disposal; the sodium could be processed to a sodium nitrate solution and solidified. All containers will be so arranged in the storage facilities so that the first container stored will be the first container shipped. Sodium bearing components such as cold traps will be placed in special containers and disposed of in a manner to be determined.

Q. <u>Will effluent and environmental effects be measured and monitored during the operation of the plant?</u>

A. Monitoring programs will be conducted before and during construction and operation of the plant and will cover radiological, chemical, thermal, meteorological and ecological considerations. Radiological monitoring will cover plant effluent systems and environmental monitoring. The plant effluent monitoring system will monitor and record radiation levels and concentrations of radioactivity in the gaseous and liquid effluent release points.

The environmental radiation monitoring program will include measurements of direct gamma radiation and sampling of airborne radioactivity, fallout particulate matter, rainfall, well and public water supplies, soil, vegetation, milk, fish, clams, bottom sediment, periphyton and river water. This program will be continually evaluated to insure that the most sensitive vectors are being sampled for the proper evaluation of exposure of the population. It will also be closely coordinated with other agencies' programs, such as the nationwide fallout sampling and water quality networks and the radiological health programs of the State of Tennessee.

Operational water quality monitoring, meteorological monitoring and thermal effluent monitoring will be conducted regularly as well as periodic ecological monitoring. Ecological monitoring is designed to evaluate the impact of plant operation on the structure and function of the terrestrial and aquatic ecosystems. This program will include the monitoring of moisture impacts, icing damage, drift impact and circulating cooling water impacts such as heated water discharges, impingement of organisms on intake structure, entrainment of biota and discharge of chemicals.

Q. <u>What are the present radiological characteristics of the area and how will the CRBRP affect them?</u>

A. The plant site is located in the Oak Ridge area which has, over the past 30 years, served as the site for a variety of nuclear facilities such as the Oak Ridge Gaseous Diffusion Plant, Oak Ridge National Laboratory, and the Y-12 Plant. It is known that certain radionuclides have been introduced into the environment (especially the river) by these sources.

Programs for environmental monitoring have been in effect since initiation of operations in the Oak Ridge area. Data from these monitoring programs have shown that the area surrounding the Clinch River site is presently characterized by air and aquatic radioactivity levels that are well below maximum permissible concentrations as outlined in 10 CFR 20, Appendix B for unrestricted areas. Any above normal releases of radioactivity from the CRBRP will be distinguished from the present background levels by the plant operational effluent and environmental monitoring programs and corrective action taken.

The background radiological characteristics have been adequately characterized to allow detection of releases from the CRBRP which may impact the environment. During the life of the plant, any accumulation or buildup of radionuclides attributable to the CRBRP should not exist in quantities greater than trace amounts. The external and internal doses received by biota other than man via exposure to expected releases from the plant will be too low to result in detectable biological effects. Total dose from all exposure pathways to man is only 0.6 percent of the total exposure from natural radiation. Therefore, it is concluded that the CRBRP will have no detectable effect upon the general population residing near the site.

Q. <u>What types of accidents have been considered and what would their consequence be?</u>

In accordance with NRC requirements, the environmental consequences of postulated accidents were evaluated in terms of the maximum individual whole body and organ doses at the nearest site boundary. Also, doses were estimated for a number of other downwind distances and for the whole body population. The results of the evaluation for each accident indicate that all potential doses fall well within the guideline values of 10 CFR 100. Thus, no serious consequences to the environment will result.

Q. <u>How will the CRBRP affect the social and economic life in the area?</u>

A. The major effects on the social and economic life of the area will occur during the construction phase. According to the proposed schedule, a construction peak force of approximately 2400 persons will be employed in 1981. A majority of this labor force will come from the local area with the remainder from an influx of workers and their families. A detailed socio-economic study of the impacts the incoming construction workers will have on the local communities, including housing, schools, and other major public services, has concluded there will be no major adverse impacts. The Project will be beneficial to the local economy from the standpoint of more jobs, income, and spending in the local area.

During operation of the plant, a force of approximately 180 persons will be permanently employed. Benefits resulting from CRBRP operation to the local area will include direct and indirect income. Permanent employees moving into the area from other areas will stimulate the construction of housing and continued economic growth to the area through job opportunities in service and production activities.

For more information, contact:

Information Division
CLINCH RIVER BREEDER REACTOR PLANT PROJECT
Post Office Box U
Oak Ridge, Tennessee 37830
Telephone: (615) 482-9661, ext. 542