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Florida Power CORPORATION

James A. McGee
SENIOR COUNSEL

February 25, 1989

Mr. Steven C. Tribble
Director of Records and Reporting
Florida Public Service Commission
101 East Gaines Street
Tallahassee, FL 32399-0872

Re: Docket No. 870098-EI

Dear Mr. Tribble:

Enclosed for filing in the subject matter are fifteen (15) copies of the Direct Testimony of Elizabeth A. Czura, Thomas S. LaGuardia, and Kenneth E. McDonald.

Please acknowledge receipt and filing of the above by completing the form provided on the enclosed copy of this letter and returning same to this writer.

Very truly yours,

James A. McGee

JAM/jw
Enclosures
cc: Parties of Record

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Czura - 02111-89
LaGuardia - 02112-89
McDonald - 02113-89

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CERTIFICATE OF SERVICE
Docket No. 870098-EI

I HEREBY CERTIFY that a copy of the Direct Testimony of Elizabeth A. Czura, Thomas S. LaGuardia, and Kenneth E. McDonald have been served by delivery or U.S. Mail this 27th day of February, 1989, to the following:

Matthew M. Childs, Esquire
Steel, Hector & Davis
301 West College Avenue
Tallahassee, FL 32301-1406

Gail P. Fels, Esquire
Assistant City Attorney
Dade County Attorney's Office
111 NW First Street, Suite 2810
Miami, FL 33128-1993

M. Robert Christ, Esquire
Florida Public Service Commission
101 East Gaines Street
Fletcher Building - Room 226
Tallahassee, FL 32399-0863

Attorney

FLORIDA POWER CORPORATION

DOCKET NO. 870098-EI

PREPARED DIRECT TESTIMONY OF

THOMAS S. LAGUARDIA

Q. **Please state your name and business address.**

A. My name is Thomas S. LaGuardia. My business address is 148 New Milford Road East, Bridgewater, Connecticut 06752.

Q. **With whom and in what capacity are you employed?**

A. I am employed by TLG Engineering, Inc. in the capacity of president.

Q. **What are your responsibilities as president of TLG Engineering, Inc.?**

A. I am responsible for the technical and business management of the engineering consulting services in the areas of decontamination, decommissioning, waste management and general engineering for nuclear and fossil fueled generating stations.

Q. **Please describe briefly your educational and professional background.**

A. I completed my BSME at Polytechnic Institute of Brooklyn in 1962 and my MSME at the University of Connecticut in 1968. I am a registered professional engineer in Connecticut (No.

10393) and New York (No. 059389). Prior to founding TLG Engineering in April, 1982, I was employed by Gulf Nuclear Fuels Corporation (formerly United Nuclear Corporation [UNC]), Combustion Engineering, and Nuclear Energy Services.

Q. Would you please describe your experience specific to the field of nuclear decommissioning?

A. My decommissioning experience began at site representative for UNC during the BONUS reactor decommissioning in 1969 and 1970. BONUS was a 17 MWe demonstration power reactor and the largest reactor decommissioned by entombment up to that time. The program involved extensive chemical decontamination of radioactive systems, selective piping and component removal, and entombment of the reactor vessel within a massive concrete barrier. The entombment has a design life of 125 years. My role as site representative was to act as a technical liaison and provide project engineering and schedule management assistance during system decontamination, component removal, vessel entombment and facility closeout.

Following the BONUS program, I was lead engineer for UNC during the Elk River Reactor decommissioning between 1970-1974. Elk River was a 20 MWe demonstration power reactor that was decommissioned by complete dismantlement. The program involved segmentation of the reactor vessel and internals using remotely operated cutting torches, as well as the packaging, shipping and controlled burial of the segments.

Similarly, radioactive piping and components were removed, packaged, shipped and buried. Radioactive concrete was demolished by controlled blasting, and nonradioactive concrete demolished by wrecking ball to completely dismantle the facility. Initially, my role for UNC was consulting engineer and later lead engineer for UNC technical support for on-site activities.

I was Project Engineer for the detailed engineering and planning of the Shippingport Station Decommissioning Project from 1979 - 1982. Shippingport was a 72 MWe light water breeder reactor. The facility is now almost completely dismantled, and TLG, with its joint venture partner Cleveland Wrecking Company, dismantled all of the piping and components and removing contaminated concrete. My role for TLG/Cleveland was Project Director, and I selected and managed an on-site project management team to hire and supervise work crews to accomplish the dismantling. Our work is complete and was performed on schedule and within budget.

I also assisted Atomic Energy of Canada, Ltd. in the detailed engineering and planning of the 238 MWe Gentilly Unit 1 reactor. My role was to provide overall decommissioning consulting services and detailed cost estimated of alternatives.

Q. **Have you any prepared or co-authored any studies or reports on decommissioning cost estimating and technology?**

A. While at Nuclear Energy Services, I was principal investigator for the Atomic Industrial Forum decommissioning study entitled "An Engineering Evaluation of Nuclear Power Reactor Decommissioning Alternatives" (AIF/NESP-009). This study evaluated the costs, schedule and environmental impacts of decommissioning 1100 MWe reactors (Pressure Water Reactors [PWRs], Boiling Water Reactors [BWRs], and High Temperature Gas Reactors [HTGRs]).

I also co-authored the "Decommissioning Handbook" for the U.S. Department of Energy (DOE). The Handbook reported the state of the art in decommissioning technology (as of 1980), including decontamination, piping and component removal, vessel segmentation, concrete demolition, cost estimating and environmental impacts.

At TLG Engineering, I co-authored "Guidelines for Producing Commercial Nuclear Power Plant Decommissioning Cost Estimates" (AIF/NESP-036) for the Atomic Industrial Forum, National Environmental Studies Project. The Guidelines identify the elements of costs to be included in the estimation of decommissioning activities for each of the principal decommissioning alternatives. Specific guidance in cost estimating methodology and reference cost data is provided in this study. The major objective of this study is to provide a basis for consistent cost estimating methodology.

TLG Engineering also prepared a study entitled, "Identification and Evaluation of Facilitation Techniques for Decommissioning Light Water Power Reactors" (NUREG/CR-3587) for the Nuclear Regulatory Commission (NRC). The study evaluated the costs and benefits of techniques to reduce occupational exposure and waste volume from decommissioning. TLG Engineering has prepared site-specific decommissioning studies for most of the nuclear units in the United States at 21 fossil-fueled power plants. In addition, TLG prepared the Decommissioning Plan and Environmental Report (ER) for Dresden Unit 1, and the ER for Indian Point Unit 1.

Q. **What is the purpose of your testimony?**

A. I am presenting the results of the decommissioning cost study dated April, 1986, which was prepared by TLG Engineering, Inc. for the Crystal River Unit 3 (CR3) Nuclear Plant. This study was commissioned by the Florida Power Corporation (FPC) as owner and operator of the station. My testimony includes the decommissioning alternatives evaluated, cost and schedule estimates, and a discussion of decommissioning feasibility.

Q. Do you have an exhibit to your testimony?

A. Yes, I will sponsor the decommissioning cost study identified in the preceding answer, which is contained in Section H of the Crystal River Nuclear Plant Decommissioning Study filed by FPC in this proceeding on January 26, 1987.

Q. What was the objective of the decommissioning cost study your firm prepared for Florida Power Corporation?

A. The objective of this study was to estimate the cost of decommissioning CR3 so that the contributions required to establish a decommissioning fund can be determined. The study is not a detailed decommissioning engineering plan, and therefore does not commit the participants to a specific course of action for the station following ultimate plant shutdown.

Q. **Would you please summarize the decommissioning costs identified by your study?**

A. The total cost to decommission and completely dismantle CR3 is estimated to be $176,576,500. This cost was developed in constant 1985 dollars and includes a 25% contingency allowance for the 72 month program. The cost estimate does not include future inflation or consider the cost of money over the time period involved.

Q. **Please describe how the decommissioning study was performed.**

A. The study was developed using the detailed engineering drawings, together with plant description and inventory documents provided by FPC as owner and operator. These drawings and documents were used to identify the general arrangement of the facility and to determine an estimate of building concrete volumes, steel quantities, numbers and size of components and degree of site restoration required. I personally made a site inspection of the plant, including access to the facility to determine movement of heavy equipment (cranes, fork-lifts, front-end loaders) close to the structures for demolition and removal work.

Decommissioning is a labor-intensive program. Representative labor rates for each geographical region and each craft or salaried work group are essential for development of a meaningful site-specific decommissioning cost estimate. Accordingly, FPC provided typical craft labor rates and utility salary data.

Rates for shipping radioactive wastes for burial were obtained from tariffs published by Tri-State Motor Transit. Tri-State Motor Transit is a reputable carrier with many years of experience in handling radioactive fuel and low level radioactive wastes. Transportation costs are an important element of decommissioning costs and recent rates must be used for accurate site-specific cost estimates. For this study, we assumed all low-level radioactive waste would be shipped to a hypothetical regional burial ground within 500 miles of the CR3 site. For cost estimating purposes, the burial costs for radioactive materials were developed using the rate schedule of an existing disposal facility, i.e., the Barnwell Low-Level Radioactive Waste Management Facility.

Q. **What Federal Regulations applicable to decommissioning were taken into account by your study?**

A. The Nuclear Regulatory Commission (NRC) has regulations dealing with the issue of decommissioning. These regulations are identified in Title 10 of the US Code of Federal Regulations (CFR) Parts 20, 30, 40, 50, 51, 70, and

72, and specific guidance for their implementation is provided in NRC Regulatory Guide 1.86 (June, 1974).

The NRC published the Final Rule entitled "General Requirements for Decommissioning Nuclear Facilities" in the Federal Register on June 27, 1988 to establish technical and financial criteria for decommissioning licensed facilities. The new NRC Rule recognizes the advantages of a site-specific cost estimate for decommissioning funding, and recommends that decommissioning be accomplished in the shortest practical time following cessation of operations. It identifies three acceptable decommissioning alternatives: DECON (prompt removal/dismantling), SAFSTOR (mothballing), and under special circumstances ENTOMB (entombment). Delayed decommissioning following initial mothballing or entombment activities should not exceed more than 60 years, unless it can be shown necessary to protect public health and safety. The Rule appears to discourage the ENTOMB alternative unless specific advantages can be shown. Both the DECON and SAFSTOR alternatives are considered reasonable options for decommissioning light water power reactors. The Rule also requires utilities to perform a periodic review of the funding plan over the life of the facility. The site-specific cost estimate and decommissioning alternatives for CR3 fully satisfy this new regulation.

Q. Would you next discuss the methodology used to prepare the decommissioning cost estimate for CR3?

A. The methodology used to develop the cost estimate followed the basic approach presented in the AIF/NESP-036 study report, "Guidelines for Producing Commercial Nuclear Power Plant Decommissioning Cost Estimates", and the U.S. DOE "Decommissioning Handbook" referred to earlier. These references use a unit cost factor method for estimating decommissioning activity costs to standardize the estimating calculations. Unit cost factors for activities such as concrete removal ($/cu yd), steel removal ($/ton), and cutting costs ($/in.) were developed from the labor and material information provided by FPC. With the item quantity (cu. yds, tons, inches, etc.) developed from plant drawings and inventory documents, the activity-dependent costs for decontamination, removal, packaging, shipping and burial were estimated. The activity duration critical path derived from such key activities, e.g., the disposition of the Nuclear Steam Supply System (NSSS), was used to determine the total decommissioning program schedule.

The program schedule is used to determine the period-dependent costs such as program management, administration, field engineering, equipment rental, quality assurance and security. the salary and hourly rates are typical for personnel associated with period-dependent costs. The costs for conventional demolition of non-radioactive structures, materials, backfill, landscaping and equipment rental were obtained from conventional demolition references such as R. S. Means, "Building Construction Cost Data 1985." In addition, collateral costs were included for heavy equipment rental or purchase, safety equipment and supplies, energy costs, permits, taxes, and insurance.

The activity-dependent, period-dependent, and collateral costs were added to develop the total decommissioning costs. A 25% contingency was added to allow for the effect of unpredictable program problems on costs. Such a contingency is appropriate for a project of this size and type, as will be discussed later in this testimony.

One of the primary objectives of every decommissioning program is to protect public health and safety. The cost estimate for CR3 decommissioning activities includes the necessary planning, engineering and implementation to provide this protection to the public.

Q. **What effect does the removal of spent fuel and other high level waste have on decommissioning costs identified in the CR3 study?**

A. None. Although decommissioning of a site cannot be complete without the removal of all spent fuel and source material, the disposition of high-level waste is outside the scope of decommissioning. In accordance with the Nuclear Waste Policy Act of 1982 (Public Law 94-425), the DOE is required by law to enter into contracts with owners and/or generators of spent fuel, with the DOE responsible for final disposition of spent fuel as high-level nuclear waste. To cover the cost of spent fuel disposition, the DOE assesses the facility operator 1 mill/kWh on net electrical generation. Therefore, the cost and disposal of spent fuel is accounted for separately and is specifically excluded from the decommissioning estimates.

All radioactive wastes generated during the decommissioning process are low-level radioactive wastes and will be transported to a federal or state licensed commercial low-level waste facility or state licensed commercial low-level waste facility for ultimate disposal, as required by the appropriate regulations in effect at the time of decommissioning.

Q. **What Decommissioning alternative was utilized in preparing CR3's cost estimate?**

A. The NRC has stated that a decommissioning alternative is acceptable if it provides for completion of decommissioning within 60 years. Consideration will be given to an alternative which provides for completion of decommissioning beyond 60 years only when necessary to protect the public health and safety.

The decommissioning cost estimate prepared for CR3 was based on the prompt removal/dismantling alternative known as DECON. The DECON alternative consists of removing from the site the spent fuel assemblies discharged from the reactor and stored on site. (As noted earlier, the cost associated with the disposition of fuel and source material is not included in this estimate.) All radioactive wastes from plant operation would be packaged and shipped for controlled burial. The operating license would be converted to a possession-only license for the decommissioning operations. A possession-only license permits the owner to possess the radioactive material under reduced Technical Specification requirements, but prohibits operation of the reactor. The radioactive fission and corrosion products and all other radioactive materials having activities above accepted unrestricted levels would be removed, packaged and shipped for disposal. The site may then be released following NRC approval, for unrestricted use with no requirement for a license. The remainder of the reactor facility could then be dismantled to make the site available for alternative use.

Q. **Why do you consider the DECON alternative to be the preferred decommissioning method for CR3?**

A. The DECON alternative provides the most reasonable means for terminating the license for the site in the shortest possible time, and consequently relieves FPC of its regulatory and liability obligations at the site. Furthermore, this scenario avoids the long-term costs and commitments associated with the maintenance, surveillance and security requirements of the conventional delayed dismantling alternatives, SAFSTOR and ENTOMB.

This alternative also allows use of the plant's knowledgeable current operating staff, a valuable asst to a well managed, efficient decommissioning program. All equipment needed to support decommissioning operations such as cranes, ventilation systems and radwaste processing equipment would be fully operational. In addition, the site would be available for alternative uses in the near term.

Q. **Would you describe the various stages and activities involved in the decommissioning of a nuclear power reactor such as CR3?**

A. Approximately two years prior to final shutdown, engineering and planning would begin on the preparation of the Decommissioning Engineering Plan and Environmental Assessment. The Plan describes the status of the facility at shutdown, work to be accomplished, safety analyses associated with each of the major activities, general procedures and sequence to be followed, and final site condition upon completion of all work. Similarly, the environmental assessment would evaluate environmental effects (radiation exposure) to workers and the public, and waste generation effects on the site and environment. These documents would be submitted to the NRC and other regulatory agencies for review and approval, and authorization to proceed. Decommissioning activities would then be conducted in three stages.

<u>Period 1 - Site Preparations.</u> The first stage would begin upon shutdown of the facility, and would involve site preparations to initiate decommissioning. The operating license may be converted to a possession-only license which permits decommissioning activities to be performed, while reducing unnecessary Technical Specifications requirements associated with normal plant operations. All spent fuel

would be removed from the reactor vessel and loaded into casks for transport to a federal repository. Alternatively, the fuel could be transferred to storage facilities on-site so as not to impact the decommissioning process. As noted earlier, fuel removal activities, packaging, shipping and disposal are not considered part of decommissioning and no costs are included in the decommissioning estimate for this work nor is any impact on decommissioning from the presence of such material on-site considered in the estimates. All fluids and wastes remaining from plant operations would be removed from the site and all systems nonessential to decommissioning would be isolated and rained. This work is expected to require approximately 12 months to accomplish.

Period 2 - Decommissioning Operations. The principle decommissioning activities would begin upon receipt of the dismantling order from the NRC. This phase of the work involves the removal of radioactivity from the site and termination of the license. The activities include selective decontamination of contaminated systems, e.g., using aggressive chemical solvents to dissolve corrosion films holding radionuclides, thereby reducing radiation levels.

While effective, the decontamination processes are not expected to reduce residual radioactivity to the levels necessary to release the material as clean scrap. Therefore, all contaminated components will have to be removed for controlled burial. However, decontamination will reduce personnel exposure and permit workers to operate in the immediate vicinity of most components, cutting and removing them for controlled disposition at a low-level waste burial facility.

All piping to and from major components such as the steam generators will be cut and removed. The steam generators and other major components will be removed intact and sealed so that they may be shipped as their own containers for disposal. Smaller components will be loaded into containers and shipped for burial. The reactor vessel and its internals will be segmented into sections and remotely loaded into steel liners for transport to the burial facility in heavily shielded shipping casks. The reactor vessel and internals have sufficiently high radiation levels to require all cutting to be done underwater (to shield the workers), or behind heavy shields, using cutting torches operated by remote control.

Concrete immediately surrounding the reactor vessel is expected to be radioactive (activated) and will be removed by controlled blasting. This blasting process is well developed and safe and is the most cost effective way to remove the heavily-reinforced concrete from the structure. Sections of interior floors within areas of the containment and other buildings in the power block are expected to be surface contaminated from exposure to contaminated air/water as a result of plant operations. This contamination will be removed by scarification (surface removal) so the remaining surface will be clean and not require costly controlled burial. All contaminated process equipment, pipe hangers, supports and electrical components will be removed and disposed of by controlled burial. An extensive radiation survey will be performed to ensure all radioactivity above the levels specified has been removed from the site. The facility may then be released for unrestricted access. Once verified the NRC can then terminate the license for the site. This period is expected to require approximately three years to accomplish all activities.

<u>Period 3 - Dismantling Remaining Structures.</u> The final stage would involve the demolition of all remaining structures, typically to a depth of three feet below grade. Clean rubble would be used on-site for fill and additional soil would be used to cover each subgrade structure. The

site would be graded. This period is expected to require approximately two years to accomplish all activities.

Q. How should the cost estimate developed in your study be viewed with respect to its validity for future application?

A. The decommissioning cost estimate prepared for CR3 is based on current state-of-the-art technology and on existing federal regulations. No provision has been made to include the future effect on costs of such factors as improvements in technology, major regulatory changes, inflation levels, etc., to ensure there will be no double accounting for such factors when projecting costs to the expected date of decommissioning. It is my recommendation that FPC thoroughly review this estimate periodically and revise it, if necessary, to account for cost increases or decreases which may result from future technology and regulations. It is my understanding that the practice followed by this Commission is consistent with this recommendation.

Q. What is the basis for the 25% contingency allowance included in CR3's cost estimate?

A. The purpose of the contingency allowance is to provide for the costs of high probability program problems where the occurrence, duration, and severity cannot be accurately predicted. The American Association of Cost Engineers (AACE) defines contingency in their "Cost Engineers Notebook" as follows:

> Contingency - specific provision for unforeseeable elements of cost within the defined project scope; particularly important where previous experience relating estimates and actual costs has shown that unforeseeable events which will increase costs are likely to occur.

Therefore, the objective of the contingency is to account for the costs of high probability program problems where the occurrence, duration, and severity cannot be accurately predicted and have not been included in the basic estimate. Past decommissioning experience has shown that these problems are likely to occur and may have a cumulative impact.

A more extensive discussion of contingency is included in the AIF/NESP-036 Guidelines Study (Chapter 13) referred to earlier. In that study, we examined the major activity-related problems (decontamination, segmentation, equipment handling, packaging, shipping and burial) with respect to reasons for contingency. Individual activity contingencies ranged from 10% to 75%, depending on the degree of difficulty judged to be appropriate from our actual decommissioning experience. The overall contingency, when applied to the appropriate components of a standard cost estimate, results in an average of approximately 25%.

Therefore, we recommend that a 25% contingency be added to the total estimated costs for financial planning purposes.

Independent of our preparation of the AIF/NESP-036 study and its predecessor report, AIF/NESP-009, Battelle Pacific Northwest Labs prepared independent decommissioning cost estimates for the NRC for a 1175 MWe PWR (NUREG CR-0130) and an 1155 MWe BWR (NUREG CR-0672). Battelle concurred with the 25% contingency allowance.

Furthermore, the Federal Energy Regulatory Commission (FERC) adopted 25% contingency as reasonable, following the ruling of Judge Liebman in the Middle South Energy/Grand Gulf Case (Docket ER82-616), decision issued February 3, 1984. Numerous state public utility commissions have adopted 25% contingency, as evidenced by an American Gas Association/Edison Electric Institute Depreciation Committee Survey which showed that at least 21 of 32 utility survey respondents had included 25% contingency in their estimates. Of the 15 utilities who filed rate cases, 11 had approval to use 25% contingency for their plant decommissioning studies.

Q. Is there any empirical evidence that complete dismantlement is a feasible decommissioning alternative for CR3?

A. There is extensive experience in the United States and in other countries for the complete dismantling of nuclear plants. This experience includes the chemical decontamination, component removal, packaging, shipping and burial, and building demolition. This directly related experience is evidence that FPC's nuclear unit can be completely dismantled.

Between 1960 and 1979, 68 licensed nuclear reactors had been or were in the process of being decommissioned in the United States. Of these, five were nuclear power plants, four were demonstration nuclear power plants, six were licensed test reactors, 28 were research reactors, and the remaining 25 were critical reactors and/or facilities decommissioned or scheduled to be decommissioned. These reactors have been or will be totally dismantled, with their licenses terminated. Many other reactor facilities in the U.S., Canada and Europe have been successfully decommissioned using demonstrated techniques. France has decommissioned 13 reactors, West Germany 6, Italy 8, Japan 7, Switzerland 2, United Kingdom 5, and Canada 2.

The feasibility of decommissioning in the U.S. is well documented in the successful dismantling of Shippingport Atomic Power Station, Elk River Reactor, Walter Reed Army Research Reactor, Ames Laboratory Reactor and Sodium

Reactor Experiment (SRE) Facilities. Internationally, the decommissioning programs underway in England (Windscale Reactor), West Germany, (Gundremmingen), and Japan (Japan Power Demonstration Reactor) are further evidence of demonstrated technology. The basic activities of cutting pipe, segmenting vessels, demolishing reinforced concrete and decontaminating contaminated systems and structures are independent of the size of the structure or megawatt rating of the plant on a unit cost factor basis ($/cut, $/cu yd, etc.). A contaminated 12-inch diameter pipe in a 3000 MWt plant takes as long to cut as it does in a 50 MWt plant, although the number of cuts will be greater in the larger plant. The technology of such cutting is well established.

The major activities include removal and burial of contaminated piping and components using conventional power hack saws, oxyacetylene or plasma arc torches within a contamination control tent. Removal of the reactor vessel and internals can be accomplished using an arc-gouging fuel gas torch or an arc saw which is currently capable of cutting through carbon and stainless steel up to 12 inches thick (current vessels are less than 10 inches thick). The remote manipulator technology required to cut the reactor vessel and internals was developed by Oak Ridge National Laboratory for the Elk River Reactor dismantling. This technology uses the plasma arc torch for cutting. This same tool was used in the SRE vessel cutting activity.

Many of the tools and techniques used in decommissioning have been used in operating plants for maintenance and equipment replacement programs. This technology is, therefore, not unique and provides further evidence of the feasibility of decommissioning.

In 1979, Virginia Electric and Power Company removed and replaced the contaminated 823 MWe steam generators in its Surry plants. The contaminated steam generators (measuring 65 feet high by 170 inches outside diameter with 3.5 inch thick walls) each weighted 340 tons. The reactor coolant system stainless steel piping (34 inch inside diameter), steam piping (30 inch diameter) and feedwater piping (14 inch diameter) were cut with a plasma arc torch to isolate the steam generator from the primary and secondary systems.

The steam generator shell was circumferentially cut at the transition cone with the plasma arc torch. The two lower shell sections were removed through the existing equipment hatch for disposal. In 1981, a similar steam generator removal program was initiated and successfully performed by Florida Power & Light Company at its Turkey Point Station. Controlled blasting concrete demolition methods are well developed. They have been used in the mining industry, and were successfully demonstrated in the demolition of the Elk River Reactor. Heavily reinforced eight feet thick concrete sections of the biological shield were safely removed with explosives, without damaging or interfering with the operation of adjacent operating power generating units. The successful application of these decommissioning techniques in both small and large nuclear power plants demonstrates assurance of decommissioning feasibility. Both the technology and the methodology for efficient decommissioning are available and fully tested.

Q. **Does that conclude your testimony?**

A. Yes.