UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
POWER AUTHORITY OF THE STATE OF NEW YORK	)	Docket No. 50-549
	)	
(Greene County Nuclear Power Plant)	)	

SUPPLEMENTAL TESTIMONY OF NRC STAFF IN RESPONSE TO CITIZENS TO PRESERVE THE HUDSON VALLEY, STIPULATED CONTENTION I.B.2

by

James J. Watt
Marcus Greenberg
Felix Litton
Frank Rinaldi

James J. Watt
Marcus Greenberg
Felix Litton
Rank Rinaldi

<u>Marcus Greenberg</u>. Intervenor Citizens to Preserve the Hudson Valley have questioned various design features and safety aspects of the proposed Greene County Nuclear Power Plant. This testimony addresses Contention I.B.2 which states:

> I. The Preliminary Safety Analysis Report ("PSAR") prepared by the Applicant does not provide reasonable assurance, as required by 10 CFR §50.46 and §50.40 that (a) the health and safety of the public will not be endangered, and (b) the Applicant is financially qualified to engage in the proposed activities in accordance with the Commission's regulations in the following respects...
>
> B. The PSAR is deficient with regard to its description and analysis of the following design features or principal safety considerations as required by 10 CFR §50.34:
>
> 2. The adequacy of missile protection design to meet Commission criteria such as the generation of pump fly-wheel missiles by reactor coolant pump overspeed.

<u>Introduction</u>. The contention states that the Preliminary Safety Analysis Report (PSAR) is deficient with regard to description and analysis of missile protection. The Staff assumed from the wording of this contention that the Intervenor is concerned only about missiles internally generated either inside or outside containment.

The Applicant in preparing the PSAR, and the Staff in reviewing it, were guided by 10 CFR Part 50.34(a) which sets forth the information the licensee must provide in a PSAR. Section 50.34(a)(3) requires that the preliminary design of the facility include:

1. the principal design criteria for the facility (i.e., the General Design Criteria set forth in Appendix A to 10 CFR Part 50);
2. the design bases and their relation to the principal design criteria; and
3. information relative to materials of construction, general arrangement, and approximate dimensions, sufficient to provide reasonable assurance that the final design will conform to the design bases with adequate margin for safety.

In reviewing the PSAR the Staff is primarily interested in determining: (1) the methodology to be employed by the Applicant to achieve compliance with the general design criteria, and (2) whether the Applicant has complied with the general design criteria. For internally generated missiles inside and outside containment, the Staff is specifically reviewing the PSAR to determine whether: (1) the Applicant has identified the systems, structures and components needed for safety, i.e., those structures, systems, and components that provide reasonable assurance that the facility can be operated without undue risk to the health and safety of the public; (2) the Applicant has identified the possible sources of types of internally generated missiles; and (3) the Applicant has provided protection against internally generated missiles.

The purpose of this testimony is to address protection from internally generated missiles inside and outside containment and the reactor coolant pump flywheel. Mr. Watt has addressed internally generated missiles inside containment, Mr. Greenberg internally generated missiles outside containment, Mr. Rinaldi the adequacy of barrier protection against missiles, and Mr. Litton the reactor coolant pump flywheel.

Before discussing the contention it is useful to make some general comments about the concept of missile protection and accident analysis. It should be understood that the Staff is of the opinion that if adequate protection and prevention against missiles are provided, then an accident from a missile is not considered credible.

James J. Watt

The Applicant addresses missile protection inside containment in Section 3.5 of the PSAR. He commits to design objectives selected to (1) assure that the integrity of the containment system is maintained; (2) ensure the capability for shutdown and maintenance of core cooling; (3) assure that a missile accident which is not a LOCA shall not initiate a loss of coolant.

The Staff interprets these objectives to be in conformance with the intent of General Design Criterion 4--Environmental and Missile Design Bases, i.e., structures, systems, and components important to safety shall be appropriately protected against the effects of missiles.

In addition to identifying design objectives, the Applicant states that his fundamental design approach is to arrange the components so that the direction of missile flight is away from critical structures and components. In areas where protection by arrangement cannot be achieved, suitable barriers or energy-absorbing material will be provided. This stated approach is in conformance with the acceptance criteria at the construction permit stage as provided in Standard Review Plan Section 3.5.1.2-II--Internally Generated Missiles (Inside Containment).

The Applicant describes his methods of missile selection and then identifies and describes postulated missiles associated with the pressurizer, the reactor vessel and control rod drive assembly, and the steam generators. Methods of missile classification and the analysis technique to be applied to missiles and barriers are presented. The Staff considered this to adequately demonstrate the approach and methods to be applied in achieving the design objectives.

The above discussion is the basis for the Staff determination that sufficient information has been provided in the PSAR to satisfy licensing requirements relative to missiles inside containment. The final design will be reviewed at the operating license stage to verify that design objectives have been implemented.

<u>Marcus Greenberg</u>. My testimony relates to missiles internally generated outside containment. In Section 3.2 of the PSAR the Applicant identified and classified the various safety components, including those outside containment, which must be protected against internally generated missiles (See Table 3.2.5-1).

In Section 3.5 of the PSAR the Applicant stated that the design of the facility considers both internally generated missiles in containment and outside containment. Outside containment, pressurized components (i.e., valve bonnets, valve stems and retaining bolts) and rotating machinery, were considered the most credible sources of internally generated missiles. Past experience has shown that missile protection against internally generated missiles is best achieved by separating the trains of redundant safety systems and by arranging the components in those trains so that the direction of missile flight is away from the critical structures and components. This method of protection, by orientation, was employed in the design of the Greene County plant wherever possible (e.g., the two engineered safety features areas, with each area housing one train of the same essential redundant components needed for safe shutdown, located on an arc of 80 degrees, approximately 200 feet apart). See PSAR Figs. 1.2-6 sheets 1 and 2 of 19. They are further separated by rooms housing non-essential equipment and are located out of the path of potential low- and high-pressure stage turbine missiles. In areas where separation by equipment arrangement could not be achieved, protection was obtained by providing suitable barriers or energy-absorbing materials (see Section 3.5.2 of the SER). To obtain additional protection, the Applicant located redundant engineered safety feature systems so that they will be separated in a manner such that a failure in one of the trains cannot cause the failure of the other, or that the failure of any plant component which brings about the need for these engineered safety feature systems does not render the safety system inoperative. See P&I diagrams in Section 9 of the PSAR for examples of piping separation of redundant trains. As a result of our review we found the design of this facility in compliance with the requirements as stated in General Design Criterion 4 with respect to protecting structures, systems, and components against the effects of internally generated missiles to maintain their essential safety functions and, therefore, acceptable for the construction permit stage.

Frank Rinaldi. My testimony addresses the barrier design procedures employed by the Applicant where physical separation was not possible. I have reviewed the procedures that will be used in the design of the structures, shields and barriers to resist the effect of missiles. My evaluation and conclusions relating to missiles internally generated inside and outside containment are found in the Safety Evaluation Report related to construction of Greene County Nuclear Power Plant, NUREG-0283 (1977) and Supplement No. 1 at Section 3.5.2. I adopt as my testimony those portions relating to barrier designs for missiles internally generated inside and outside containment.

Felix Litton. The purpose of this testimony is to reply to a contention posed by Intervenor Citizens to Preserve the Hudson Valley, I.B.2, regarding the adequacy of missile protection generated from a loss of integrity of the reactor pump flywheel.

The problems associated with reactor coolant pump flywheels and methods of minimizing the probability of a loss of the integrity of the reactor coolant pump flywheels for the Greene County Nuclear Power Plant are described in Section 5.4.1 of the Greene County SER. The following testimony is in supplementation of the SER.

The reactor coolant pump flywheels for the Greene County Nuclear Power Plant are designed, fabricated, tested, examined and inspected in use in compliance with the requirements of Regulatory Guide 1.14, "Reactor Coolant Pump Flywheel Integrity." Compliance with Regulatory Guide 1.14 provides a basis acceptable to the Staff for satisfying Criterion 4, "Environmental and Missile Design Basis," of Appendix A of 10 CFR Part 50. An adequate margin of safety for the loss of integrity of the pump flywheels is ensured through conformance to these recommendations and requirements. Therefore, the Staff concludes that the generation of missiles from the loss of integrity of the pump flywheel is a low-probability event and is not inimical to the health and safety of the public.

In addition, a generic review is being conducted of overspeed conditions by the NSSS vendors, EPRI and the Staff. In the event the results of the review indicate that additional safety measures are warranted, post-construction permit design changes will be made to ensure that the acceptable safety margin is maintained.

The flywheel material will conform to ASTM Specification A-508, Class 4, nickel-chromium-molybdenum steel forging.1/ The steel making process used to produce the material will minimize flaws and provide acceptable material fracture toughness. The nil-ducility temperature is no higher than -50°F plus -7°F for each inch over six-inch thickness. The upper shelf energy level is at least 50 ft-lbs. Fabrication of the flywheels from ductile, vacuum-processed, high-strength steel forgings possessing high toughness will provide acceptable margins against brittle fracture and flaw propagation during operation.

The flywheels are fabricated as simple circular solid discs, which are shrunk on the motor shaft. The fa ication and testing are rigidly monitored by Quality Assurance personnel. Each flywheel is subjected to 100% volumetric examination using procedures in compliance to Class 1 components of Section III of the ASME Boiler and Pressure Vessel Code.

Normal and anticipated transient conditions are used as the basis for design. The specified reactor pump operating speed is 1200 rpm.

1/ The PSAR Section 5.2.6 describes the fracture toughness properties of three materials that may be used for the manufacture of pump flywheels. In addition to the nickel-chromium-molybdenum forging referenced in the testimony of the Applicant, the PSAR Section 5.2.6 referenced the properties of SA-543 Class 1 nickel-chomium-molybdenum and SA-533 Class 1 nickel-manganese-molybdenum plate materials. These materials all have adequate fracture toughness and may be used for the manufacture of pump flywheels.

The maximum speed is anticipated to be less than the transient turbine trip condition, or about 115 percent of the normal pump speed. The flywheels are designed, analyzed and tested to operate at 1500 rpm, 125 percent of the operating speed. The minimum speed for ductile failure is calculated to be greater than 3200 rpm, when the conservative limits of Regulatory Guide 1.14 are applied in the calculation.

We conclude from our review that the measures taken by the Greene County Nuclear Power Plant to ensure integrity of the reactor coolant pump flywheel satisfy the recommendations of Regulatory Guide 1.14, "Reactor Coolant Pump Flywheel Integrity" and are sufficient to provide an adequate margin of safety. Compliance with Regulatory Guide 1.14 provides a basis acceptable to the Staff for satisfying Criterion 4, "Environmental and Missile Design Basis," of Appendix A of 10 CFR Part 50. Our conclusion is based on the following information submitted in the PSAR in Section 5.2.6.

1. Normal and anticipated transient conditions are used as a basis in flywheel design.

2. The flywheels will be made of ASTM Specification A-508, Class 4, forged high-strength steel. This material has controlled and demonstrated high strength and fracture toughness properties.

3. Each flywheel will be spin tested at 125 percent of the maximum synchronous speed of the pump motor.

4. The flywheel will be subjected to a 100 percent volumetric preservice examination in accordance with the procedures and criteria

of Section III of the ASME Boiler and Pressure Vessel Code.

5. Pump flywheels will be ultrasonically examined during service in order to detect either material degradation or flaw propagation, should they occur.

We conclude that an adequate margin of safety for the loss of integrity of the reactor coolant pump flywheels is ensured through the conformance to the recommendations of Regulatory Guide 1.14. Compliance to these criteria provides a basis acceptable to the Staff for satisfying Criterion 4 of Appendix A of 10 CFR Part 50.

Professional Qualifications

of

Marcus Greenberg

Auxiliary Systems Branch

Division of Systems Safety

My name is Marcus Greenberg, I am a senior Systems Engineer in the Auxiliary Systems Branch, Division of Systems Safety, Nuclear Regulatory Commission. My duties and responsibilities as a systems engineer are to review and evaluate the applicant's safety analysis report for adequacy of technical and engineering design criteria of the auxiliary systems of nuclear power plants submitted for licensing. The primary purpose of the review is to verify the bases for the conclusion that the proposed design of the auxiliary systems is sound and that the systems will be capable of performing their intended functions.

My formal education consists of a B.S. in Mechanical Engineering from Illinois Institute of Technology. Graduate work at American University and George Washington toward a Master's degree in Management Sciences and Operations Research. I have also taken continuing education courses in engineering at the University of Michigan and Massachusettes Institute of Technology and have completed an in-house course in Nuclear Engineering and a Nuclear Power Reactor Safety course at Massachusettes Institute of Technology.

I have approximately 34 years experience in engineering: 13 years with private industry; 16 1/2 years with the U.S. Army Corps of Engineers; and 4 years with NRC (formerly AEC). In private industry I was responsible for the design of mechanical systems, i.e., heating, ventilation, and air conditioning systems for apartment buildings, hospitals, and schools, for Architects-Engineers. With the Corps of Engineers I was responsible for checking the design, inspection, and testing of mechanical systems i.e., power plant heating systems, sewage and water treatment systems, and ventilation systems for military buildings. I was responsible for supervising the construction and installation of all the mechanical systems, including a unique trichlorethylene refrigeration system, for the Army Cold Region Research Laboratory. I also conducted research in the development and verification of the feasibility of heat sink concepts to receive and store rejected heat from a nuclear powered underground installation. This work was performed for the Army Engineer Reactor Group, Fort Belvoir, Virginia.

I have authored or co-authored 19 technical reports and papers on a diversity of subjects, i.e., the design and construction of a Remote Facility for artic use, anemometry at low velocities, hydrometry in the frost zone, heat sink concepts, including a report on an "Analytical Method for Determining Heat Transfer from Power Plant Coolant to the Florida Boulder Zone." Four of the reports/papers were presented at conferences including the Army Scientific Conference and an ASME conference in Washington.

PROFESSIONAL QUALIFICATIONS

FELIX B. LITTON

I am a Senior Materials Engineer in the Materials Engineering Branch of the Office of Nuclear Reactor Regulation, Nuclear Regulatory Commission. I am attached to the Materials Integrity Section and am responsible for the review and evaluation of materials and processes used in the construction and operation of components in the nuclear power industry.

My education consists of a B. S. (1936) and M. S. (1937) degree in Physical Chemistry from Virginia Polytechnic Institute, Blacksburg, Va. I have completed additional study in Material Science (1967) at the University of New Mexico and have taken special courses in Fracture Mechanics (1977) at George Washington University.

Prior to joining the Nuclear Regulatory Commission, my experience consists of metallurgical research related to the preparation, fabrication and alloy formation of new structural materials for nuclear, advanced aircraft and high temperature application. I have published in technical journals on the environmental behavior, thermodynamic stability and mechanical properties of uranium, plutonium, vanadium, zirconium, titanium, hafnium and silicon and their alloys. My experience in ferrous metallurgy relates to the cause of failure in service.

PROFESSIONAL QUALIFICATION

OF

FRANK RINALDI

I am a Structural Engineer in the Structural Engineering Branch of the Office of Nuclear Reactor Regulation, Nuclear Regulatory Commission. I am responsible for the review and evaluation of adequacy of criteria used in the structural design and analysis of Seismic Category I structures, systems and components of nuclear power plants assigned to the Structural Engineering Branch.

I received a Bachelor Degree in Civil Engineering from the City College of New York in 1966 and a Master of Science in Civil Engineering from the University of Maryland in 1974.

I am a registered Professional Engineer in the State of Virginia and a member of Working Group on Concrete Containments and of the Main Committee of the ASME/ACI 359 (Code for Concrete Reactor Vessels and Containments).

My professional experience includes:

1974 - Present	Structural Engineer, Structural Engineering Branch, Division of Systems Safety, Office of Nuclear Reactor Regulation, U.S N.R.C.
1971 - 1974	Structural Engineer, Fuel Fabrication and Transportation Branch, Division of Materials Licensing, U.S.A.E.C.
1970 - 1971	General Engineer, Division of Research, Development, Testing and Evaluation, Naval Facilities Engineering Command, U.S. Navy Department.
1968 - 1970	Structural Engineer, Electronics Support Branch, Naval Facilities Engineering Command, U.S. Navy Department
1966 - 1968	Civil Engineer, Chesapeake Division, Naval Facilities Engineering Command, U.S. Navy Department