

July 13, 2009

**UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION**

BEFORE THE SECRETARY

)	
In the Matter of)	
)	Docket No. 50-391
Tennessee Valley Authority)	
)	
(Watts Bar Unit 2))	
)	

PETITION TO INTERVENE AND REQUEST FOR HEARING

I. INTRODUCTION

Pursuant to 10 C.F.R. § 2.309 and the notice published by the Nuclear Regulatory Commission (“NRC” or “Commission”) at 74 Fed. Reg. 20,350 (May 1, 2009), Petitioners Southern Alliance for Clean Energy (“SACE”), Tennessee Environmental Council (“TEC”), We the People (“WTP”), the Sierra Club, and Blue Ridge Environmental Defense League (“BREDL”) hereby request a hearing and petition to intervene in this proceeding regarding the Tennessee Valley Authority’s (“TVA’s”) updated application for a facility operating license (“OL”) for the Watts Bar Nuclear Plant (“WBN”) Unit 2. Petitioners’ standing to intervene is described in Section II of this pleading, and Petitioners’ contentions are set forth in Section III.

This proceeding is highly unusual in that TVA’s updated OL application follows a lengthy hiatus in the WBN Unit 2 OL proceeding: TVA submitted its Final Environmental Statement for construction of WBN Units 1 and 2 in 1972 (TVA, Final Environmental Statement, Watts Bar Nuclear Plant Units 1 and 2 (1972) (“FES”)), and was issued construction permits for both units in January 1973. Final Supplemental Environmental Impact Statement for the Completion and Operation of Watts Bar Nuclear Plant Unit 2, at 5 (2007) (“FSEIS”). TVA

then submitted an OL application for both units in 1976, but suspended construction in 1985 before the operating license for WBN Unit 2 had been issued. *Id.* At the point construction was halted, WBN Unit 2 was 80 percent complete. *Id.* TVA later decided to defer both completion of Unit 2 and pursuance of its corresponding OL application. *Id.* Thirty-seven years have thus passed since TVA prepared its EIS for construction of the facility.

TVA itself recognizes that its 1972 FES is significantly out-of-date. The title of the FSEIS is therefore specifically addressed to both “completion of construction” and “operation” of WBN Unit 2. In addition, TVA explains in Chapter 1 that the FSEIS “updates” the FES with respect to the need for power and energy alternatives. FSEIS at 1.

TVA’s approach of updating its construction EIS after the passage of such a lengthy and eventful period of time is consistent with NRC regulations and federal case law, which require the supplementation of EISs in the face of new and significant information or changed circumstances. *See* 10 C.F.R. § 51.92, *Marsh v. Oregon Natural Resources Council*, 490 U.S. 360, 374 (1989).

Thus, by TVA’s own request, and consistent with the National Environmental Policy Act (“NEPA”), this proceeding covers the updating of TVA’s 1972 FES with respect to the need for power and alternatives. While these issues would otherwise be precluded from consideration by 10 C.F.R. §§ 51.53(b) and 51.95(b), TVA’s own actions have opened them to challenge here. *Southern Nuclear Operating Company* (Early Site Permit for Vogtle ESP Site), LBP-07-03, 65 NRC 237, 270 (2007).

II. DESCRIPTION OF PETITIONERS AND THEIR STANDING TO INTERVENE

A. Description of Petitioners

Petitioners are civic and environmental groups located in the geographic area of WBN Unit 2, whose members' safety, environmental and economic interests would be adversely affected by the unsafe operation of WBN Unit 2.

SACE is a nonprofit membership organization that promotes responsible energy choices that solve global warming problems and ensure clean, safe and healthy communities throughout the Southeast. SACE is headquartered in Knoxville, Tennessee and has staff and members throughout the Southeast.

TEC is a Tennessee-based nonprofit organization of about 1,000 members that seeks to educate and advocate for the conservation and improvement of Tennessee's natural environment. TEC also works to protect and conserve Tennessee's communities, public health, and the natural resources on which they depend.

WTP is a nonprofit organization that is involved in communities across America. WTP is dedicated to educating the public about risks associated with nuclear power, including the use of less dangerous and more cost effective alternative energy sources. WTP is also actively involved in exposing the truth about public health and safety issues, including the adequacy of industry oversight by the Nuclear Regulatory Commission. WTP has members that live within the evacuation zone of the Watts Bar Plant.

The Sierra Club is a national nonprofit organization of approximately 1.3 million members and supporters dedicated to exploring, enjoying, and protecting the wild places of the earth; to practicing and promoting the responsible use of the earth's ecosystems and resources; to educating and enlisting humanity to protect and restore the quality of the natural and human

environment; and to using all lawful means to carry out these objectives. The Sierra Club has approximately 6,400 members in Tennessee alone. The Tennessee Chapter has members who live and work in the vicinity of the Watts Bar plant and are affected by the plant.

BREDL is a regional, community-based nonprofit environmental organization whose founding principles include earth stewardship, environmental democracy, social justice, and community empowerment. BREDL encourages government agencies and citizens to take responsibility for conserving and protecting our natural resources. BREDL advocates grassroots involvement to empower whole communities in environmental issues, and also functions as a “watchdog” of the environment by monitoring issues and holding government officials accountable for their actions.

B. Standing to Intervene

Pursuant to 10 C.F.R. § 2.309(d)(1), a request for a hearing must address: (1) the nature of the petitioner’s right under the Atomic Energy Act (“AEA”) to be made a party to the proceeding, (2) the nature and extent of the petitioner’s property, financial, or other interest in the proceeding, and (3) the possible effect of any order that may be entered in the proceeding on the petitioner’s interest. The Atomic Safety and Licensing Board (“ASLB”) summarized these standing requirements as follows:

In determining whether a petitioner has sufficient interest to intervene in a proceeding, the Commission has traditionally applied judicial concepts of standing. Contemporaneous judicial standards for standing require a petitioner to demonstrate that (1) it has suffered or will suffer a distinct and palpable harm that constitutes injury-in-fact within the zone of interest arguably protected by the governing statutes (*e.g.*, the Atomic Energy Act of 1954 and the National Environmental Policy Act of 1969); (2) the injury can fairly be traced to the challenged actions; and (3) the injury is likely to be redressed by a favorable decision. An organization that wishes to intervene in a proceeding may do so either in its own right by demonstrating harm to its organizational interests, or in a representational capacity by demonstrating harm to its members. To intervene in a representational capacity, an organization must show not only that at least one of its

members would fulfill the standing requirements, but also that he or she has authorized the organization to represent his or her interests.

Pacific Gas & Electric Co. (Diablo Canyon Power Plant Independent Spent Fuel Storage Installation), LBP-02-23, 56 NRC 413, 426 (2002).

Petitioners' standing to participate in this proceeding is demonstrated by the declarations of the following members of the Petitioner organizations, who have authorized Petitioners to represent their interests in this proceeding (Attachment 1):

Sandra Kurtz, SACE member
Louis Gorenflo, SACE and BREDL member
Carol Kimmons, TEC member
Yvonne Derrickson, TEC member
Jean Cheely, TEC member
William Ross McCluney, Sierra Club member
William F. Reynolds, Sierra Club member
Ann P. Harris, We the People member
Dennis Gregg, BREDL member

The attached declarations demonstrate that Petitioners' members live within 50 miles of WBN Unit 2. Petitioners therefore have presumptive standing by virtue of their proximity to the nuclear plant that may be operated on the site. *Diablo Canyon*, 56 NRC at 426-27 (citing *Florida Power & Light Co.* (Turkey Point Nuclear Generating Plant, Units 3 and 4), LBP-01-06, 53 NRC 138, 146, *aff'd*, CLI-01-17, 54 NRC 3 (2001)).

Petitioners seek to protect their members' health, safety and lives, as well as the health and safety of the general public and the environment by opposing operation of WBN Unit 2 through intervention in the Watts Bar Unit 2 proceeding. Petitioners seek to ensure that no OL is issued by the NRC unless TVA demonstrates full compliance with federal laws designed to protect public health and the environment from unsafe operation of the plant, which TVA has thus far failed to do.

III. CONTENTIONS

As required in the Federal Register notice, Petitioners set forth below the specific contentions that they seek to have litigated in this proceeding. 74 Fed. Reg. at 20,351. With the exception of Contention 5, all of the contentions raise challenges to the FSEIS for its failure to comply with NEPA and its implementing regulations. Contention 5 raises NEPA and safety challenges to the NRC's proposed Waste Confidence Decision Update, 73 Fed. Reg. 59,551 (October 9, 2008) ("Proposed Waste Confidence Decision"), and its proposed rule for Consideration of Environmental Impacts of Temporary Storage of Spent Fuel After Cessation of Reactor Operation, 73 Fed. Reg. 59,547 (October 9, 2008) ("Proposed Spent Fuel Storage Rule").

Contention 1: Failure to List and Discuss Compliance With Required Federal Permits, Approvals and Regulations

TVA's FSEIS is inadequate to satisfy 10 C.F.R. §§ 51.53(b) and 51.45(d) because the document fails to list or discuss the status of its compliance with permits, approvals and environmental standards. Petitioners are aware of at least two such permits or approvals that should be but are not listed in the FSEIS, and there may be more of which Petitioners are unaware.

Basis and Discussion:

Under NRC's regulations for implementation of NEPA, a license applicant must include in its environmental report a list of "all Federal permits, licenses, approvals, and other entitlements which must be obtained in connection with the proposed action." 10 C.F.R. § 51.45(d). It must also "describe the status of compliance with these requirements." *Id.* Additionally, the report must contain a "discussion of the status of compliance with applicable environmental quality standards and requirements including . . . thermal and other water

pollution limitations or requirements which have been imposed by Federal, State, regional, and local agencies having responsibility for environmental protection.” *Id.*

Here, TVA has failed to comply with these requirements by neglecting to discuss, or even list, the approvals, permits and standards that it must comply with prior to being issued an operating license. Petitioners are aware of two permits or approvals that should be listed and discussed in the FSEIS.

First, TVA must address its compliance with a 1991 agreement between TVA and several other Federal and Tennessee state agencies for an interagency review of certain classes of proposed activities in the Watts Bar Reservoir area. Interagency Agreement, Watts Bar Reservoir Permit Coordination, February 1991 (“Agreement”) (Attachment 2). The Agreement was entered into in 1991 by TVA, the U.S. Army Corps of Engineers (“Army Corps”), the U.S. Department of Energy (“DOE”), the U.S. Environmental Protection Agency (“EPA”) and the Tennessee Department of Health and Environment (“TDHE”) in response to the accumulation of contaminants in the Watts Bar Reservoir sediment that were a product of earlier DOE operations at Oak Ridge, Tennessee. Agreement at 2. The Agreement calls for “interagency coordination and review of permitting and other use authorization activities by [the Army Corps and TVA] which could result in the disturbance, resuspension, removal and/or disposal of contaminated sediments or potentially contaminated sediments in the Watts Bar Reservoir.” *Id.* A working group (“WG”) comprised of one representative from each agency classifies all proposed actions at or near the reservoir as creating either “no significant sediment disturbance”, “marginal sediment disturbance” (“MSD”), or “potential major sediment disturbance” (“PMSD”). *Id.* at 4. The Agreement also identifies specific categories of actions that automatically fall within a particular classification. Attachment 2 to Agreement, 8-11. For any action classified as MSD or

PMSD, each agency is to review the application and provide recommendations about whether to approve the action. *Id.* at 4-6.

WBN Unit 2 falls squarely within the designated geographic area to which the Agreement applies. *See* Attachment 1 to Agreement. In addition, TVA is undertaking at least one category of action that is listed in the Agreement as a PMSD: fixed water intake for commercial or industrial purposes. Agreement at 11. As such, TVA is required to submit its proposal to the WG for review before taking action. TVA's EIS, however, does not state whether this step was ever taken.

Second, the TVA must discuss the status of its National Pollution Discharge Elimination System ("NPDES") permit for wastewater discharges from WBN into the Tennessee River. State of Tennessee, NPDES Permit No. TN0020168 (Feb. 8, 2005) ("NPDES Permit"). NEPA requires that TVA provide discussions of the status of its compliance with respect to both the Agreement and the NPDES Permit. The permit expired more than two years ago and has not yet been reissued by the Tennessee Department of Environment and Conservation ("TDEC"). Although TDEC is currently reviewing TVA's application for re-issuance of the permit, the new permit has not yet been issued. TVA remains bound, however, by the terms of the expired permit until the new permit is issued. Therefore, under the plain language of NRC's NEPA regulations, TVA's EIS must discuss the fact that the permit is expired, and explain the status of its application for reissuance of the permit, including whether TVA is in compliance with the terms of the expired permit under which it remains bound.

There may be other federal permits, approvals, and environmental quality standards applicable to WBN Unit 2 of which Petitioners are unaware. The FSEIS should list and discuss all of them.

Contention 2: Inadequate SAMA Uncertainty Analysis

The WBN Unit 2 Severe Accident Mitigation Alternatives Analysis (“SAMA Analysis”) is inadequate to satisfy NEPA and 10 C.F.R. § 51.53(b) with respect to consideration of alternatives to mitigate the consequences of severe accidents. The SAMA’s uncertainty analysis does not fully account for the sensitivity of its results with regard to uncertainties in Level 3 parameters, such as meteorological conditions and radionuclide release fractions. Full consideration of Level 3 uncertainties would have a significant impact on the cost of a severe accident and could increase the number of SAMAs that would be cost-beneficial.

Basis and Discussion

This contention is supported by the expert Declaration of Dr. Edwin S. Lyman (July 10, 2009) (Attachment 3).

The SAMA analysis (submitted by TVA to NRC by letter dated January 21, 2009) is based on the calculation of risk-weighted doses and costs resulting from severe accidents. The calculation of these risk-weighted consequences requires a full Level 3 Probabilistic Risk Assessment (“PRA”), which builds on Level 1 and Level 2 PRAs. A Level 1 PRA is used to calculate the annual frequency of core damage. The Level 2 PRA is used to calculate the frequencies of the various plant damage states that could occur after core damage, and the characteristics of the radionuclide releases that would result in each case. The Level 3 PRA is used to calculate the consequences resulting from radionuclide releases to the environment. It depends on many factors, including the magnitude of radionuclide releases, the meteorological conditions, the downwind population, and the nature of the emergency response measures enacted.

In Section 9 of the SAMA Analysis, TVA presents the results of an analysis that evaluated the sensitivity of the SAMA conclusions with regard to PRA uncertainties. *Id.* at 29. In the list of conditions for which TVA assessed the sensitivity of the SAMA conclusions, TVA claims to have used “the 95th percentile PRA [probabilistic risk assessment] results in place of the mean PRA results.” *Id.* at 29-30.

TVA’s assertion is not correct. In fact, Section 9.2 shows that TVA only considered the 95th percentile values of the core damage frequency (CDF) (a Level 1 PRA calculation) and Large Early Release Frequency (LERF) (a Level 2 PRA calculation). *Id.* at 31. TVA does not claim to have used the 95th percentile PRA results for consideration of Level 3 uncertainties, and indeed it is clear that TVA did not do so. As a result, TVA’s sensitivity analysis fails to account for uncertainties that could have a significant effect on the doses and costs resulting from the accident, and hence could have a significant effect on the outcome of the SAMA Analysis.

In particular, TVA does not assess the impact of meteorological variations. TVA claims that “meteorological data . . . have been studied extensively . . . and been shown to result in relatively small changes in overall risk.” SAMA Analysis at 32. But TVA does not claim to have reached that conclusion by using the 95th percentile PRA results to evaluate the uncertainties in its SAMA Analysis (or that of any other nuclear plant) with respect to meteorological variations. In fact, TVA’s conclusion is inconsistent with an independent study by Dr. Lyman which shows that the variation in consequences computed by the MACCS2 code over a year’s worth of meteorological data is generally quite significant.¹

¹ Edwin S. Lyman, Union of Concerned Scientists, “A Critique of the Radiological Consequence Assessment Conducted in Support of the Indian Point Severe Accident Mitigation Alternatives Analysis,” commissioned by Riverkeeper, Inc. (November 2007).

Consequence calculations, as carried out by the MACCS2 code, generate a series of results based on random sampling of a year's worth of weather data. The code also has the option to utilize the entire year's meteorological data set. The code provides a statistical distribution of the results. Dr. Lyman finds, based on his own MACCS2 calculations for other plants such as Indian Point, that the ratio of the 95th percentile to the mean of this distribution is typically a factor of three to four for outcomes such as early fatalities, latent cancer fatalities and off-site economic consequences. *Id.*

An additional increase in consequences by a factor of three would have a significant impact on the outcome of the SAMA Analysis, because it would lead to a corresponding increase in the benefits of mitigation measures. For example, Table 19 of the SAMA Analysis provides the impacts of using the Level 1 (CDF) 95th percentile values on the Phase 2 SAMA candidates, and finds that the outcome of the cost-benefit test would change for only one SAMA. However, if the benefit increased by an additional factor of three, seven of the eighteen SAMAs listed in Table 19 would become cost-beneficial.

A review of the information provided on the Phase 1 SAMA screening indicates that a number of SAMAs that were screened out on the basis of excessive implementation cost, such as SAMA 9 (provide an additional diesel generator), would become cost-beneficial if the benefit increased by a factor of four.

Another set of Level 3 parameters with uncertainties that could have a significant effect on SAMA outcomes are the radionuclide release fractions associated with early containment failure. In Table 7 of the SAMA Analysis, one set of release fractions are given for each containment damage state. However, there is actually a large range of possible release fractions for each containment damage state, as documented in NUREG-1465, "Accident Source Terms

for Light-Water Nuclear Power Plants” (February 1995), and supporting documents such as NUREG/CR-5747, “Estimate of Radionuclide Release Characteristics into Containment Under Severe Accident Conditions” (November 1993). These documents show that the 95th percentile of the uncertainty distributions for radionuclide release fractions such as that for the cesium class are typically a factor of three to four greater than the means of the distributions. It has been shown that increases in release fractions of this magnitude would correspond to increases in consequences (and hence benefits) by a similar factor (three to four).²

Thus, if the full uncertainty distribution for the Level 3 consequence calculation were evaluated, considering the spread in both the meteorological variations and the radionuclide release fractions, it is clear that the 95th percentile values would be at least an additional order of magnitude greater than the values computed with the mean CDF, LERF, meteorological conditions and release fractions. This would raise the “maximum benefit” of mitigation measures to over \$15 million. The increase in the value of mitigation measures would not only change the outcome for all Phase 2 SAMAs rejected by TVA but would also likely render many of the rejected Phase 1 SAMAs suitable for more detailed evaluation.

Contention 3: Inadequate Consideration of Severe Accident Mitigation Alternatives With Respect to AC Backup for Diesel Generators

The SAMA Analysis is inadequate to comply with NEPA and 10 C.F.R. § 51.53(b) with respect to consideration of severe accident mitigation alternatives (“SAMAs”) because it does not provide enough information to permit a reasonable assessment of the reliability of its AC power backup option for resolution of GSI-189, “Susceptibility of Ice Condenser and Mark III Containments to Early Failure From Hydrogen Combustion During A Severe Accident.” In light

² U.S. Nuclear Regulatory Commission, “Technical Assessment Summary for GSI-189,” attachment 4 (ADAMS accession number ML023510187).

of the significant reliability problems already experienced at Sequoyah and WBN Unit 1 with their voluntary measures for GSI-189 mitigation, TVA should be required to conduct a Phase 2 analysis of a range of measures for ensuring the reliability of its alternate power supply, including mandatory dedication of backup diesel generators, independence of the backup power supply to the igniters from backup power to other systems, and seismic qualification.

Basis and Discussion:

This contention is supported by the expert Declaration of Dr. Edwin S. Lyman (July 10, 2009) (Attachment 3).

Generic Safety Issue 189 (GSI-189) concerns the finding that ice condenser containment pressurized water reactors, such as WB2, are highly vulnerable to early containment failure resulting from hydrogen explosions during a severe accident, as documented in NUREG/CR-6427, “Assessment of the Direct Containment Heating Issue for Plants with Ice Condenser Containments” (April 2000). In particular, during a station blackout (SBO), when no off-site or on-site AC power is available, the design-basis hydrogen igniter systems would be inoperable and unable to mitigate the risk of hydrogen explosion and early containment failure. Because of the severity of the consequences of early containment failure and the low cost of options to mitigate the risk, the NRC’s Office of Nuclear Regulatory Research (RES) concluded in 2002 that action to provide back-up power to one train of igniters in the event of an SBO was cost-beneficial and hence mandatory action was warranted. Memorandum to from Ashok C. Thadani to Samuel L. Collins, “RES Proposed Recommendation for Resolving Generic Safety Issue 189” (Dec. 17, 2002). Subsequently, the Office of Nuclear Reactor Regulation (NRR) also concluded that a new requirement for backup power to the igniter system was warranted by both defense-in-depth considerations and Backfit Rule analysis. Memorandum from Suzanne C. Black to John

T. Larkins, “Background Information for Presentation on Generic Safety Issue 189,” at 10 (Sept. 20, 2003).

However, in the face of significant licensee opposition, the NRC never completed the rulemaking. Instead, NRR performed a new and highly unusual cost-benefit analysis assuming as a baseline certain voluntary actions proposed by ice condenser licensees. NRC, “Regulatory Analysis: Proposed Action to Address Generic Safety Issue 189” (May 24, 2005). For TVA ice condenser plants (Sequoyah and WBN Unit 1), this entailed a voluntary commitment to provide additional trailer-mounted, commercial-grade, 2-megawatt diesel generators for each unit to “provide back-up power to plant systems, including either train of hydrogen igniters for an affected unit.” Letter from Preston Swafford, TVA, to NRC, “Sequoyah Nuclear Plant (SQN) Units 1 and 2, and Watts Bar Nuclear Plant (WBN) Unit 1 – Enhancement of the Capability of the Containment Hydrogen Igniters” (Mar. 6, 2007). The results of NRR’s revised analysis confirmed that a requirement for addition of backup power to the igniters was cost-beneficial, but ceased to be so if voluntary actions were credited. *Id.* As a result, NRR reversed its earlier decision and decided to accept voluntary actions in lieu of rulemaking. NRC, “Regulatory Analysis: Proposed Action to Address Generic Safety Issue 189” (May 24, 2005).

In the case of Sequoyah and WBN Unit 1, the additional backup diesel generator was assumed to reduce the SBO frequency by a factor of ten (*e.g.*, it was assumed to be 90 percent reliable), reducing the benefit of mitigating an SBO by a factor of ten and rendering the cost of additional measures to power the igniters in the event of an SBO greater than the benefit.

However, both Sequoyah and WBN Unit 1 have had reliability issues associated with the voluntary implementation of a backup supply of AC power, bringing into question whether the

effectiveness of the backup system would be as high as 90 percent. In the case of WBN Unit 1, a 2008 inspection report states that:

the inspector was unable to determine, by official record, that the movement of the power supply and connection of necessary fittings and cables to provide backup power to the igniters could be completed within three hours . . . The licensee responded that because this issue was beyond the design basis, components and activities were not treated as safety-related or under the quality assurance program. Hence, no official documentation was required, and none was generated.³

U.S. NRC, “Watts Bar Nuclear Plant – NRC Integrated Inspection Report 05000390/2008003 and Annual Assessment Meeting Summary” (Aug. 7, 2008). The inspector thus had to rely on unofficial documentation for assurance that the timeline could be met. *Id.*

The inspector also found that licensee procedures did not indicate that the igniters should not be powered if core damage had already begun; that no drills or dry runs had been conducted since 2004, and that the companion transformer to the diesel generator had not been tested. *Id.*

At Sequoyah, a May 2009, inspection report details a “Green” finding by an inspector associated with the licensee’s failure to adequately revise procedures so that backup power would actually be provided to the igniters in the event of an SBO. Although a Green finding is the least serious category of violation, the igniters would not have worked if an SBO had occurred. NRC was unable to take enforcement action, however, because of the voluntary nature of the action. U.S. NRC, “Sequoyah Nuclear Plant – NRC Integrated Inspection Report 05000327/2009002 and Annual Assessment Meeting Summary,” May 1, 2009.

In the WBN Unit 2 SAMA Analysis, TVA states under SAMA 108 that “an alternate power supply to the hydrogen igniters was implemented,” and that, therefore, no further analysis of alternatives was needed. However, the inspection reports for Sequoyah and WBN raise

³ It is not clear why the appropriate inspection standard is three hours when SBOs at PWRs typically lead to core damage within two hours after accident initiation.

doubts about the effectiveness of the voluntary measures that TVA has implemented at these reactors to address GSI-189.

The information provided in the SAMA Analysis is thus insufficient to determine whether the alternate power supply for the hydrogen igniters will be effective and reliable, and whether the benefits of a more robust backup power supply would potentially be cost-beneficial and worthy of more detailed analysis. TVA should provide adequate information to evaluate the reliability of the power supply. It should also examine a reasonable range of measures for ensuring the reliability of the alternate power supply to the hydrogen igniters. Issues that should be considered include: mandatory dedication of the power supply; independence of the backup power supply to the igniters from backup power to other systems; and seismic qualification.

Contention 4: Inadequate Discussion of Need for Power and Energy Alternatives

The discussion of the need for power and alternatives in Sections 1.6, 2.0 and 2.6 of the FSEIS for WBN Unit 2 is inadequate to satisfy NEPA because TVA fails to demonstrate that the power which will be generated by the proposed plant is actually needed. TVA also fails to justify its rejection of less financially and environmentally costly alternatives for generating additional power or for reducing demand through energy efficiency measures.⁴

Basis and Discussion

⁴ As discussed above in Section I, Petitioners are aware that ordinarily, at the operating license stage, the NRC does not require consideration of the need for power. 10 C.F.R. §§ 51.53(b), 51.95(b). In this case, however, TVA has stated that the purpose of the FSEIS – as described in both the title and the body of the document -- is not just to support TVA's operating license, but to update TVA's 1972 EIS for construction of the plant. Therefore, neither § 51.53(b) nor 51.95(b) bars the admission of this contention. If the Atomic Safety and Licensing Board ("ASLB") should rule otherwise, Petitioners intend to submit a waiver petition pursuant to 10 C.F.R. § 2.335(b).

This contention is supported by the expert Declaration of Dr. Arjun Makhijani (July 10, 2009) (Attachment 4), and by his expert report, *Watts Bar Unit 2: Analysis of Need and Alternatives* (July 10, 2009) (“Makhijani Report”) (Attachment 5).

The NRC interprets its NEPA-implementing regulations to require construction permit applicants to evaluate the need for power and energy alternatives. As the Commission has explained:

Prior to the start of construction there has been little environmental disruption at the proposed site and only a relatively small capital investment has been made by the license applicant. Hence, real alternatives to the construction and operation of the proposed facility exist, including no additional generating capacity at all if no “need” exists or generation of the needed electricity by some non-nuclear source. In issuing this proposed rule, the Commission in no way diminishes the importance that attaches to having the most accurate possible assessment of need for power and alternative sources during the construction permit review.

Proposed Rule, Need for Power and Alternative Energy Issues in Operating License Proceedings, 46 Fed. Reg. 39,440 (August 3, 1981). TVA estimates that Watts Bar Unit 2 is sixty percent complete, with significant expenditures and modifications still to be made. FSEIS at 19.

Therefore, it is appropriate to revisit the question of need and alternatives.

As discussed in Dr. Makhijani’s report, TVA’s analysis of the need for power and alternatives is deficient in the following respects:

1. TVA’s energy demand projections are based on outdated studies, including TVA’s 1972 FES and TVA’s 1995 Integrated Resource Plan and Environmental Impact Statement (“1995 IRP”). As discussed in Dr. Makhijani’s Report at 7, the predictions of energy demand in the 1972 FES were so wildly optimistic that the delay of almost two decades in completion of WBN Unit 1 and the suspension of WBN Unit 2 did not affect TVA operations, even though construction of several other reactors was also suspended during the same period. Makhijani Report at 3, 7 and Figure 8. WBN Unit 1 did not even come on-line until 1996. *Id.*

The 1995 IRP is also outdated in a number of respects, including costs of alternatives; the state of various technologies that can be used as a baseload; and the effects of impending climate legislation on increasing efficiency. This is reflected in the fact that TVA recently instituted a process for revising the IRP by noticing its intent to publish a new EIS. TVA, Notice of Intent, Environmental Impact Statement; Integrated Resource Plan, 74 Fed. Reg. 28,322 (June 15, 2009) (“TVA Notice Regarding IRP Update”).

2. TVA also relies on the 1995 IRP in a manner that is arbitrary and inconsistent with TVA’s own policies and procedures. TVA acknowledges that the 1995 IRP specifically excludes completion of construction and operation of WBN Unit 2 from the “preferred portfolio” of energy options that it intended to pursue between 1995 and 2020. TVA tries to rationalize a departure from the 1995 IRP, however, arguing that the 1995 IRP underestimates the capacity factor for TVA’s nuclear plants. FSEIS at 19.

But this argument is not relevant because the demand forecast used in the FSEIS is already obsolete, as is the 1995 IRP. In fact, a higher capacity factor would only result in a higher potential for new generation at a time when demand is running well below 2008 levels. TVA cannot definitively state when the region will emerge from the current crisis and demand will grow beyond its peak in 2008. Makhijani Report at 2 and 3. Demand in the first half of 2009 was six percent below 2008 and at that rate is set to revert back to 2004 or 2005 levels by the end of the fiscal year. And TVA would be trying to sell more power in a context where demand is declining more generally due to the severe economic crisis and the increase in unemployment in the region. TVA’s claim that completing Watts Bar would lower electricity costs and emissions (FSEIS at 19) is not supported by any analysis as to whether costs would be lowered in the context of declining demand and lacks any comparative analysis as to whether

costs and emissions might be lowered even more if the same investments were made in efficiency and demand response. Makhijani Report at 3-4.

3. TVA also fails to justify its disregard of the energy planning process developed in the 1995 IRP. This process resulted in a “portfolio” of energy options that TVA determined was environmentally-optimal after preparing an EIS and subjecting it to public comment. Makhijani Report at 7-8. *See also* Issuance of Record of Decision, Tennessee Valley Authority, 61 Fed. Reg. 7,572 (February 28, 1996) (“TVA’s preferred alternative, the Energy Vision 2020 portfolio, contains all of the resource options that perform best under the environmental criteria and from this perspective, the portfolio can be viewed as environmentally preferable.”) If TVA wants to alter the decision reflected in the 1995 IRP, it should follow its own established procedures for revising the IRP. In fact, that process has already begun, and TVA offers no reason for disregarding it. TVA Notice Regarding IRP Updated, 74 Fed. Reg. at 28,322.

4. The FSEIS contains no analysis of the effects of the nationwide economic crisis or its effects on the TVA region, including huge increases in unemployment in the TVA region since 2007 and serious declines in power sales. Makhijani Report at 2-4. TVA’s most recent report to the Security and Exchange Commission (“SEC”), for example, states that “[s]ales of electricity are about six percent below 2008 levels and could decline further if commercial and industrial employers continue to reduce production in response to the economic downturn.” Quoted in Makhijani Report at 3.

5. The FSEIS does not contain any discussion of alternative sources of energy or alternatives to reduce demand. Makhijani Report at 4. TVA’s disregard of energy efficiency measures as an alternative is not only unreasonable from a practical standpoint, but is also

inconsistent with TVA's own 2007 strategic plan, which stresses efficiency as one of TVA's top objectives. Makhijani Report at 5.

TVA also ignores the fact that it is required by the Independence and Security Act of 2007 to consider incorporating a "smart grid" and increasing energy efficiency. *Id.* Smart grids are expected to enable better demand response and help to integrate renewable energy sources into electricity systems on a large scale. TVA has issued a report adopting policies to increase energy efficiency and promote smart grids and started the process of taking public comment on its staff report, but this is not reflected in the FSEIS. *Id.* at 5. *See also* TVA, Notice of Consideration of Energy Efficiency and Smart Grid Standards, 74 Fed. Reg. 30,360 (June 25, 2009).

6. The FSEIS does not provide a detailed analysis of any alternatives. Makhijani Report at 4-6. Moreover, TVA cannot rationally rely on the 1995 IRP's discussion of alternatives because it effectively rejected the 1995 IRP's analysis of alternatives when it decided to pursue operation of WBN Unit 2. Makhijani Report at 9.

7. The FSEIS also contains the mistaken implication that only a nuclear or fossil fuel plant can satisfy the need for baseload capacity. FEIS Section 2.0 and Makhijani Report at 6. Based on this false premise, TVA also states that the operation of Watts Bar 2 will allow it to reduce its dependence on fossil fuel. FSEIS, Section 2.6. This is no longer the case as the production of cleaner and more sustainable renewable energy sources, such as wind energy, has matured and become a major industry both in the United States and abroad. Makhijani Report at 6-7. For example, the National Renewable Energy Laboratory has developed and published a system for dispatching wind energy that has minimal CO₂ emissions. Makhijani Report at 5-6.

8. For numerous reasons set forth throughout Dr. Makhijani's Report, completion of the process for revising the IRP is necessary before TVA can claim that it has made an adequate and reasonable assessment of the need for power and alternative energy alternatives. These reasons include: TVA demand in 2009 is running at a rate well below the lowest projection in the FSEIS, the fact the present downturn resembles in some essential ways the situation the earlier energy crisis of the 1970s and early 1980s, which was so severe that demand in the TVA region did not recover and go steadily beyond its mid-1970s levels until well into the 1990s, TVA's own commitment to use the 1995 IRP process to make decisions about energy options until a new IRP process is complete, the fact the TVA itself has in effect acknowledged that its 1995 IRP is obsolete by launching a new IRP process in June 2009, the requirements of the 2007 Energy Independence and Security Act of 2007, the likely changes that will be wrought as part of impending climate legislation, and the vast technological changes that are currently ongoing in the electricity production and management sectors.

Contention 5: Inadequate Basis for Confidence in Availability of Spent Fuel Repository and Safe Means of Interim Spent Fuel Storage

The NRC published both its Proposed Waste Confidence Decision and its Proposed Spent Fuel Storage Rule on October 9, 2008. 73 Fed. Reg. 59,547 and 59,551. Neither the Proposed Waste Confidence Decision nor the Proposed Spent Fuel Storage Rule satisfies the requirements of NEPA or the Atomic Energy Act, and thus do not provide adequate support for any NEPA determination in this proceeding regarding the environmental impacts of spent fuel storage or disposal. The deficiencies in the Proposed Waste Confidence Decision also fatally undermine the adequacy of the NRC's findings in Table S-3 of 10 C.F.R. § 51.51 to satisfy NEPA.

Unless and until the NRC remedies the deficiencies in the proposed Waste Confidence Decision, Table S-3, and the Proposed Spent Fuel Storage Rule, the NRC has no lawful basis to issue a license for WBN Unit 2.

Basis and Discussion

This contention is based on, and incorporates by reference, comments submitted by SACE, BREDL, and the Sierra Club regarding the NRC's Proposed Waste Confidence Decision and Proposed Temporary Storage Rule. *See* Comments by Texans for a Sound Energy Policy, et al., Regarding NRC's Proposed Waste Confidence Decision Update and Proposed Rule Regarding Consideration of Environmental Impacts Of Temporary Storage Of Spent Fuel After Cessation Of Reactor Operations (February 6, 2009) ("Comments"), available on the NRC's electronic rulemaking docket, Docket 2008-0482, <http://www.regulations.gov/fdmspublic/component/main?main=DocketDetail&d=NRC-2008-0482>. The Comments are supported by the expert declarations and reports of Drs. Arjun Makhijani and Dr. Gordon Thompson.

This contention seeks to enforce, in this specific proceeding, the NRC's commitment that "it would not continue to license reactors if it did not have reasonable confidence that the wastes can and will in due course be disposed of safely." Proposed Waste Confidence Decision, 73 Fed. Reg. at 59,552 (citing 42 Fed. Reg. 34,391, 34,393 (July 5, 1977); *Natural Resources Defense Council v. NRC*, 582 F.2d 166 (2d Cir. 1978)). The contention also seeks to enforce NEPA's requirement that generic determinations under NEPA must be applied to individual licensing decisions and must be adequate to justify those individual decisions. As the Supreme Court held in *Baltimore Gas and Electric Co. v. Natural Resources Defense Council*, 462 U.S. 87 (1983):

The key requirement of NEPA . . . is that the agency consider and disclose the actual environmental effects in a manner that will ensure that the overall process, including both the generic rulemaking *and the individual proceedings*, brings those effects to bear on the decisions to take *particular actions that significantly affect the environment*.

462 U.S. at 96 (emphasis added). *See also State of Minnesota v. U.S. Nuclear Regulatory Commission*, 602 F.2d 412, 416 (D.C. Cir. 1979) (agreeing with the Commission that “it could properly consider the complex issue of nuclear waste disposal in a “generic” proceeding such as rulemaking, and then apply its determinations in subsequent adjudicatory proceedings”) (emphasis added). Indeed, the Commission itself has stated that it intends to use the Proposed Waste Confidence Decision to “enhance the efficiency of combined license proceedings for applications for nuclear power plants anticipated in the near future” and “assure that [the NRC’s] Waste Confidence findings are up to date.” 73 Fed. Reg. at 59,551. *See also* Proposed Temporary Storage Rule, 73 Fed. Reg. at 59,547 (“The proposed revision reflects findings that the Commission has reached in the ‘Waste Confidence’ decision update . . .”) By placing the exact same concerns raised in our Comments before the ASLB in this contention, we therefore seek to ensure, as required by NEPA and *Baltimore Gas and Electric Co.*, that whatever decisions the NRC reaches in response to our Comments on the Proposed Waste Confidence Decision and Proposed Temporary Storage Rule will be applied in a timely way to the licensing decision for WBN Unit 2, *i.e.*, before that plant is licensed. *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 349 (1989) (holding that environmental concerns must be considered *before* an action is taken).

Petitioners recognize that the issues raised by their Comments – and therefore by this contention – are generic in nature and thus do not seek to litigate them in this individual proceeding. Instead, the contention should be admitted and held in abeyance in order to avoid the necessity of a premature judicial appeal if this case should conclude before the NRC has

completed the rulemaking proceeding.⁵ If the ASLB does not consider that it has the authority to admit the contention because it presents a challenge to a generic rule, Petitioners request the ASLB to refer the contention to the Commission.

This contention is intended to be identical to the Comments that Petitioners and other groups filed with the NRC on February 6, 2009. The legal and factual issues raised contention can be summarized as follows:

The NRC has no technical basis for a finding of reasonable confidence that spent fuel can and will be safely disposed of at some time in the future. Therefore, under the Commission's own standard that "it would not continue to license reactors if it did not have reasonable confidence that the wastes can and will in due course be disposed of safely," the Commission must refuse to issue new licenses or renew existing licenses for nuclear power plants. 73 Fed. Reg. at 59,552 (citing 42 Fed. Reg. 34,391, 34,393 (July 5, 1977); *Natural Resources Defense Council v. NRC*, 582 F.2d 166 (2d Cir. 1978)).

The NRC's lack of a basis for any finding of confidence in the technical feasibility of a repository also fatally undermines Table S-3 of the NRC's Uranium Fuel Cycle Rule, which depends on the assumption that radioactive releases from a repository will be zero. Final Rule, Licensing and Regulatory Policy and Procedures for Environmental Protection; Uranium Fuel Cycle Impacts From Spent Fuel Reprocessing and Radioactive Waste Management, 44 Fed. Reg. 45,362 (August 12, 1979). Based on its own statement in the 1990 Waste Confidence rulemaking proceeding, the NRC, having arrived at a stage where any basis that it may have had

⁵ Pursuant to the Hobbs Act, 28 U.S.C. § 2344, Petitioners may take a judicial appeal as of right only if they do so within sixty days of a decision ending their participation in this case. If Petitioners should be dismissed from this proceeding before the NRC has completed the Waste Confidence Decision and Temporary Spent Fuel Storage rulemaking proceedings, however, they will be required to appeal the substantive issues raised by their contention before the issues are ripe.

for confidence in the safe disposal of spent fuel has clearly evaporated, must revisit the basis for Table S-3. *See* Review and Final Revision of Waste Confidence Decision, 55 Fed. Reg. 38,474, 38,491 (September 18, 1990) (“Unless the Commission, in a future review of the Waste Confidence decision, finds that it no longer has confidence in the technical feasibility of disposal in a mined geologic repository, the Commission will not consider it necessary to review the S-3 rule when it reexamines its Waste Confidence findings in the future.”) Certainly, the Commission no longer has any basis whatsoever for the principal assumption underlying Table S-3, which is that spent fuel can be safely disposed of in a repository, having repudiated that assumption in the proposed Waste Confidence Decision. 73 Fed. Reg. at 59,555. *See also* IEER Comments.

In both the proposed Waste Confidence Decision and the Proposed Temporary Storage Rule, the NRC continues to deny that temporary spent fuel storage poses significant environmental risks, ignoring a wealth of government reports showing that high-density fuel storage pools are vulnerable to catastrophic fires that may be caused by accidents or intentional attacks. Instead of confronting this information in a detailed EIS, the NRC calls it a security matter and shrouds it in an unjustifiably broad mantle of security-related secrecy. But the NRC is not entitled to use security concerns as an excuse for failing to comply with NEPA. *San Luis Obispo Mothers for Peace v. NRC*, 449 F.3d 1016, 1034-35 (9th Cir. 2006).

In making a finding of no significant impact (“FONSI”) with respect to spent fuel storage, the NRC has not even attempted to comply with the NRC’s procedural requirements for a FONSI, such as preparing an environmental assessment (“EA”) that addresses the purpose of and need for the proposed action and evaluates alternatives to the proposed action. The NRC also violates NEPA by failing to identify the documents on which it relies for its decision, and by

failing to disclose all portions of its decision-making documents that are non-exempt under the Freedom of Information Act (“FOIA”). *San Luis Obispo Mothers for Peace* (Diablo Canyon Independent Spent Fuel Storage Installation), CLI-08-01, 67 NRC 1, 15-17 (2008) (citing *Weinberger v. Catholic Action of Hawaii*, 454 U.S. 139, 143 (1981)).

Perhaps most importantly, the NRC fails to explain why it is justified in continuing to allow licensees to use dangerous high-density fuel storage pools to store spent fuel under protective measures whose adequacy is suspect but cannot be publicly verified, when it would be possible to virtually eliminate the danger by using low-density pool storage and hardened dry storage of spent fuel. The NRC’s secrecy is unnecessary, corrosive to the NRC’s system of accountability through open decision-making, and potentially dangerous because the decision-making process was not only secret but was restricted to the NRC and a limited group of individuals with a vested interest in minimizing the cost of mitigative measures, *i.e.*, reactor licensees.

The Proposed Waste Confidence Rule and the Proposed Temporary Storage Rule are thus utterly inadequate to satisfy the requirements of the AEA and NEPA for a generic licensing decision for new nuclear power plants. Any generic decision to allow the creation of additional spent reactor fuel and other radioactive waste associated with the uranium fuel cycle must be accompanied by thorough, supported, and well-documented safety findings; and it must also be accompanied by an environmental impact statement (“EIS”) that fully assesses the environmental impacts of the uranium cycle, including health and environmental impacts and costs, and that examines a reasonable array of alternatives, including the alternative of not producing any additional radioactive waste.

Contention 6: TVA’s EIS Fails To Satisfy The Requirements Of NEPA Because It Does Not Contain An Adequate Analysis Of The Environmental Effects Of The Impact Of A Large, Commercial Aircraft Into The Watts Bar Nuclear Plant.

NEPA and NRC regulations require TVA to include in its EIS an analysis of “reasonably foreseeable” impacts which have “catastrophic consequences, even if their probability of occurrence is low.” 40 C.F.R. § 1502.22(b)(1). An aircraft attack on WBN is a reasonably foreseeable event with potentially catastrophic consequences. TVA’s discussion and analysis of the impacts of such an event, however, falls woefully short of what is required by NEPA and, therefore, must be revisited.

Basis and Discussion

An aircraft attack on a nuclear power plant such WBN is unquestionably a reasonably foreseeable event. This is evident by the fact that the Commission has addressed such aircraft attacks several times since September 11, 2001. On February 25, 2002, for instance, NRC issued an Interim Compensatory Measures (ICM) Order that required all reactor licensees to develop and adopt mitigative strategies to cope with large fires and explosions resulting from events such as an aircraft attack. Additionally, NRC recently issued two final rules related to the impacts of an aircraft attack on a nuclear power plant: the Power Reactor Security Rule, 74 Fed. Reg. 13,926 (Mar. 27, 2009), and the Aircraft Impacts Rule, 74 Fed. Reg. 28,112 (June 12, 2009).

The Power Reactor Security Rule created 10 C.F.R. § 50.54(hh), which generally requires all holders of and applicants for operating licenses to develop “procedures for addressing certain events that are the cause of large fires and explosions that affect a substantial portion of [a] nuclear power plant,” including, but not limited to, an aircraft impact. 74 Fed. Reg. at 13,957. Section 50.54(hh)(1) requires all licensees and applicants “to develop specific procedures . . . that describe the pre-identified actions licensees intend to take when they are

provided with pre-event notification” of a potential aircraft attack. *Id.* at 13,956. Because aircraft threats are “significant, rapidly evolving threats” and because licensees “may only receive threat notifications a short time before potential onsite impacts,” the NRC determined that “it is not prudent for licensees to attempt to identify and accomplish *ad hoc* mitigative actions in the midst of such circumstances,” and that “employing a reactive approach would significantly limit the effectiveness of onsite and offsite responses.” *Id.*

Section 50.54(hh)(2), meanwhile, requires licensees and applicants to “develop and implement guidance and strategies intended to maintain or restore core cooling, containment, and spent fuel pool cooling capabilities under the circumstances associated with loss of large areas of the plant due to explosions or fire, to include strategies in the . . . areas [of]: (i) fire fighting; (ii) operations to mitigate fuel damage; and (iii) actions to minimize radiological release.” *Id.* at 13,969. Each new applicant for an operating license must therefore submit with its application a “description and plans for implementation of the guidance and strategies” that it has developed. *Id.*; 10 C.F.R. § 50.34(i).

The Aircraft Impact Rule created 10 C.F.R. § 50.150, whereby all new applicants for construction licenses, operating licenses and standard design certifications issued after July 13, 2009 must “perform a design-specific assessment of the effects on the facility of the impact of a large, commercial aircraft.” 74 Fed. Reg. 28,146 (June 12, 2009).⁶ The applicants must use

⁶ NRC expressly chose not to apply the Aircraft Impact Rule to current or future operating license applications for which construction permits have already been issued, as is the case with Watts Bar Unit 2. This is because “existing construction permits are likely to involve designs which are essentially complete and may involve sites where construction has already taken place.” *Id.* at 28,115. Therefore, according to NRC, “[a]pplying the final rule to operating license applications for which there are existing construction permits could result in an unwarranted financial burden to change a design for a plant that is partially constructed.” *Id.* Additionally, such applicants are “required to comply with the requirements in 10 C.F.R. §

“realistic analyses” to “identify and incorporate into the design those design features and functional capabilities to show that, with reduced use of operator actions: (i) the reactor core remains cooled, or the containment remains intact; and (ii) spent fuel cooling or spent fuel pool integrity is maintained.” *Id.* An applicant’s preliminary or final safety analysis report (FSAR), as applicable, must describe the design features and functional capabilities identified and how the identified design features and functional capabilities meet the assessment requirements. *Id.*

NRC regards the requirements of 10 C.F.R. §§ 50.54(hh) and 50.150 to be “complementary in scope and objective,” in that § 50.54(hh) focuses on “ensuring that . . . licensees will be able to implement effective mitigation measures for large fires and explosions,” including those caused by large aircrafts, while § 50.150 focuses on “enhancing the design of future nuclear power plants to withstand large, commercial aircraft impacts.” *Id.*

There is thus no doubt that the impacts of an aircraft attack on a nuclear plant are reasonably foreseeable and potentially catastrophic, even if the probability of such an attack occurring is low. NEPA therefore requires TVA to analyze those impacts. 10 C.F.R. § 1502.22.

TVA’s EIS, however, contains little more than one page of “analysis” related to aircraft attacks that does not discuss any of these topics. TVA instead attempts to downplay its NEPA obligations because “[t]he likelihood of [an attack] occurring is . . . remote in light of today’s heightened security awareness.” Watts Bar SEIS at 75.

In its brief discussion, TVA cites an impact analysis conducted by the Electric Power Research Institute (EPRI) in which computer models crashed a Boeing-767-400 into containment structures that were “representative of all U.S. nuclear power containment types.” *Id.* at 76.

Based on its findings and analyses, EPRI concluded that “there would be no release of

50.54(hh) to identify actions to mitigate the effects of large fires and explosions, including those caused by aircraft impacts.” *Id.*

radionuclides from any of these facilities or containers” because they are “designed to withstand potentially destructive events,” such as “earthquakes, extreme overpressures, and hurricane force winds.” *Id.* at 75-76.

This generic computer modeling is quite different, however, than the “design-specific” impact assessment required under the new Aircraft Impact Rule. Although TVA contends that the structures in EPRI’s tests were “representative of all U.S. nuclear power containment types,” there is substantial evidence that the containment unit found in Watts Bar Unit 2 is in fact significantly less resistant to impacts than other containment models. U.S. NRC, “Regulatory Analysis: Proposed Action to Address Generic Safety Issue 189” at 8 (May 24, 2005). Thus, the effects of a commercial aircraft attack on Watts Bar are likely to be very different than those observed in EPRI’s tests.

TVA then claims that the EPRI analysis “is fully consistent with research conducted by NRC.” *Id.* at 76. TVA provides no discussion of, nor any citation to, any specific research conducted by NRC in this area, however. Instead, TVA merely quotes an undocumented statement by NRC Commissioner McGaffigan that: “[O]ur research showed that in most (the vast majority of) cases an aircraft attack would not result in anything more than a very expensive industrial accident in which no radiation release would occur.” *Id.*

Finally, TVA makes only vague, generic claims about the steps it has taken since September 11th to prepare for a terrorist attack, such as increasing the level of security readiness; improving physical security measures; and increasing its security arrangements with local and federal law enforcement agencies at all of its nuclear facilities. *Id.* But a list of potential mitigation measures cannot substitute for a discussion of environmental impacts. The discussion

of mitigative measures must follow an analysis of impacts and be informed by it, otherwise it is meaningless.

TVA's FSEIS and SAMA analysis are thus insufficient to satisfy the requirements of NEPA, because they fail to address the environmental impacts of aircraft attacks on WBN Unit 2. As the Power Reactor Security Rule and Aircraft Impacts Rule clearly show, the Commission regards an aircraft attack on WBN as a reasonably foreseeable event and NEPA therefore requires TVA to present a more complete impact analysis. *San Luis Obispo Mothers for Peace v. NRC*, 449 F.3d 1016, 1031 (9th Cir. 2006) (finding that "the possibility of a terrorist attack [on a nuclear power plant] is not so 'remote and highly speculative' as to be beyond NEPA's requirements.")⁷

Contention 7: Inadequate Consideration of Aquatic Impacts

TVA claims that the cumulative impacts of WBN Unit 2 on aquatic ecology will be insignificant (FSEIS Table S-1 at page. S-2, and Table 2-1 at page. 30). TVA's conclusion is not reasonable or adequately supported, and therefore it fails to satisfy 10 C.F.R. § 51.53(b) and NEPA.

TVA's discussion of aquatic impacts is deficient in three key respects. First; TVA mischaracterizes the current health of the ecosystem as good, and therefore fails to evaluate the impacts of WBN2 in light of the fragility of the host environment. Second, TVA relies on outdated and inadequate data to predict thermal impacts and the impacts of entrainment and impingement of aquatic organisms in the plant's cooling system. Third, TVA fails completely to

⁷ While Petitioners recognize that the Commission has refused to apply the *Mothers for Peace* decision as precedent in circuits other than the U.S Ninth Circuit, Petitioners believe that this position is inconsistent with NEPA and that the decision should, therefore, be applied in all reactor licensing decisions.

analyze the cumulative effects of WBN2 when taken together with the impacts of other industrial facilities and the effects of the many dams on the Tennessee River.

Basis and Discussion

This contention is supported by the expert declaration of Dr. Shawn Paul Young (July 11, 2009) (Attachment 6) (“Young Declaration”).

WBN’s cooling system has two sets of cooling water intakes, located at different points along the Tennessee River, and one set of outfalls. The original cooling system for WBN was a closed-cycle cooling system, with intakes and outfalls located on the upper end of Lake Chickamauga. In 1998, when the closed cycle cooling system proved insufficient, TVA supplemented WBN’s intake capacity by converting the intakes from an unused fossil fuel plant to a Supplemental Condenser Cooling Water (“SCCW”) system for WBN Unit 1. In effect, the SCCW system is a once-through cooling system . FSEIS at 24. The intake for the SCCW is at the lower end of Watts Bar Reservoir, which lies upstream of the WBN plant. TVA continued to use the original outfall from the unused fossil fuel plant on Lake Chickamauga, however. WBN thus currently withdraws water from intake structures at two different locations, and it also discharges thermal effluent through two different outfalls.

TVA’s finding that WBN Unit 2 will have no significant impacts on aquatic life in the Tennessee River is inadequately supported in the following respects:

1. TVA’s conclusion that cumulative impacts will be insignificant is based on the faulty premise that the aquatic ecosystem that will be affected by WBN Unit 2 is currently in a good state of health. In fact, data in TVA’s own environmental studies, as well as available literature, show that the health of the Tennessee River ecosystem, including Lake Chickamauga where WBN Units 1 and 2 are located, is damaged, fragile, and quite vulnerable to the additional

impacts that would be posed by WBN Unit 2's cooling water system. Young Declaration at ¶ III.A.1.

The Tennessee River is an extraordinarily diverse and unique ecosystem that supports over 200 fish species, including twenty species that are found only in the Tennessee River. Young Declaration at ¶ III.B.1. Yet the ecosystem also harbors the highest number of imperiled species of any large river basin in North America. *Id.* at ¶ III.B.2. TVA incorrectly portrays the ecosystem as healthy, when its health and diversity are actually in steep decline. *Id.* at ¶¶ III.C.1-9. TVA asserts, for example, that the freshwater mussel communities are in "excellent" health because their population is "constant." But, in fact, the mussel population is only constant because it is not reproducing, which is a sign of poor health. *Id.*

By characterizing the health of fish and benthic organisms as "good" or "excellent," TVA rationalizes its failure to take a hard look at the reasons why these species are declining. While dams may be the primary cause of these ill effects, they are not the only contributor. *Id.* at ¶ III.C.10. TVA has not taken the necessary steps to evaluate how the effluent from WBN Units 1 and 2 may contribute to the stresses on the fragile health of fish communities, or how these facilities may interfere with mussel reproduction. *Id.* at ¶¶ III.C.6,9.

2. TVA relies on outdated and inadequate data to predict the effects of WBN Unit 2's cooling system on fish, mussels, and other aquatic organisms. In particular, the FSEIS understates the potential impacts of the coolant intake system (*i.e.*, entrainment and impingement) and the thermal impacts of the coolant discharge system on fish and benthic organisms, by relying on poor or outdated data, distorted interpretations of data, and assumptions and extrapolations in lieu of recent monitoring studies. Young Declaration at ¶ III.A.2.

Given their lack of mobility, fish eggs and most fish larvae cannot escape the intake flow velocity and are sucked into the intake canal and cooling system. Phytoplankton and zooplankton, which constitute important food sources for fish, mussels, and aquatic insects, may also be entrained due to their lack of mobility. Fish and other organisms pass through the plant's cooling system, suffering injury or death through physical contact, rapid pressure or temperature change, and chemical poisoning from biocides and other chemicals introduced into the water. *Id.* at ¶ III.D.5.

. Knowledge of the ichthyoplankton population distribution in relation to intakes across time and space is very important to an understanding of entrainment impacts, because ichthyoplankton tend to be patchy (high numbers clumped into a specific portion of the water column). This patchy distribution creates a high level of vulnerability to entrainment mortality if the organisms are located near intakes, because they cannot simply avoid the intakes. But TVA has not collected sufficient data to understand the distribution of ichthyoplankton populations or how they are affected by the Watts Bar intakes. That is because TVA has not taken direct measurements of entrainment, even though direct measurements are recommended by the U.S. Environmental Protection Agency. Instead, it has extrapolated entrainment estimates from outdated and inadequate data. *Id.* at ¶¶ III.D.7-10.

TVA's conclusion that entrainment impacts are insignificant is based upon an unsupported assumption: that population densities are uniform across the river channel and from the surface to the bottom of the river. The data do not support this assumption, however, because the numbers are all relative, expressed in percentages. It is therefore impossible to determine what the actual populations of organisms are. *Id.* at ¶¶ III.D.11-13. TVA also does not provide

any data for fish eggs, which may be found in high abundance during different times of the year and are very vulnerable to entrainment. *Id.* at ¶¶ III.D.14-15.

TVA's impingement data are likewise inadequate to support the FSEIS' finding of no significant impact. For instance, TVA failed to follow-up on a survey conducted at the SCCW intake that found an increased level of impingement in comparison to earlier surveys. *Id.* at ¶ III.D.16. TVA also failed to update the thirty-five-year-old data on which it relied for its conclusions about impingement impacts at the WBN Unit 1 intake. Additionally, TVA inappropriately treats its impingement data for the Lake Chickamauga and Watts Bar Reservoir intakes as if they were the same. The vicinities of the two intakes, however, have very different habitat characteristics and are therefore likely to support very different populations of aquatic organisms. *Id.* at ¶ III.D.17.

TVA further states that thermal impacts will be insignificant, even though TVA's conclusions are contradicted by its own acknowledgement of the need to relocate mussels in the vicinity of the SCCW discharge to avoid mortality from elevated temperatures. *Id.* at ¶ III.E.2. And TVA provides no evidence, such as scientific studies or field observations, to justify its conclusion. *Id.* For instance, TVA is missing a number of basic data sets with respect to thermal impacts, including data on overall drift communities, and data on spatial and temporal distribution of ichthyoplankton in relation to thermal mixing zones. *Id.* at ¶ III.E.3.a. Other factors neglected by TVA (which must be understood in order to properly assess thermal impacts on aquatic life), include characteristics of the thermal plume; variations in the size and temperature profile of the mixing zone; the temperatures in the core of the thermal plume (rather than at the edge) and whether they have an effect on aquatic organisms; and the effects of high

temperatures on fish eggs and larvae, which are highly vulnerable to elevated and rapidly changing temperature. *Id.* at ¶¶ III.E.3.b-f.

Finally, TVA fails to show that it has accounted for the impacts of overflow from the holding ponds, where excess cooling water may be stored at very high temperatures. *Id.* at ¶ III.E.4.

3. TVA does not adequately address the cumulative impacts of WBN Unit 2 in conjunction with the impacts of the numerous water impoundments on the Tennessee River, or with other industrial facilities such as the ten fossil fuel-burning plants, the six operating nuclear reactors, and the five additional reactors for which TVA has sought operating licenses. Each of these facilities affects the Tennessee River continuum. That is, each facility not only affects the immediate environment, but those changes are then felt throughout the river as a domino effect.

The portion of the Tennessee River in the vicinity of WBN is an important part of the river continuum, as are all other segments of the river. Each segment has its own complex ecological balance that is required to support a diverse population of fish and other organisms, providing different habitats needed at different life history stages that must match available food and habitat needs in time and space. Each new industrial facility that is added to the environment will compound the existing disruptions to these interrelated aquatic ecosystems, and further remove the Tennessee River from any semblance of the natural state which would be necessary to restore or even halt the deterioration of the hundreds of declining, threatened, and endangered aquatic species in the Tennessee River Basin. Young Declaration at ¶ III.A.3.

The FSEIS is thus inadequate because it does not contain a discussion of these cumulative industrial impacts or the degree to which WBN Unit 2 will contribute to them.

IV. CONCLUSION

For the foregoing reasons, Petitioners have demonstrated that they have standing and that their contentions are admissible. Therefore, they are entitled to a hearing on their contentions.

Respectfully submitted,

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July 13, 2009

CERTIFICATE OF SERVICE

I certify that on June 13, 2009, I posted copies of the foregoing Petition to Intervene and Request for Hearing on the NRC's Electronic Information Exchange System. It is my understanding that as a result, the following parties were served:

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(signed electronically by)
Matthew D. Fraser

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE SECRETARY

_____)	
In the Matter of)	
Tennessee Valley Authority)	Docket No. 50-391
Watts Bar Plant Unit 2)	
_____)	

DECLARATION OF STANDING

Under penalty of perjury, Sandra Kurtz declares as follows:

1. My name is Sandra Kurtz. I am a member of the Southern Alliance for Clean Energy.
2. I live at 3701 Skylark Trail, Chattanooga, TN 37416.
3. My home lies within 42.5 miles of the site in Rhea County, Tennessee where Tennessee Valley Authority (TVA) proposes to finish building and operate an additional reactor on the site of Watts Bar Unit 1 is located.
4. TVA originally submitted the application for Watts Bar Units 1 and 2 on June 30, 1976. Though TVA completed Unit 1 and the Nuclear Regulatory Commission (NRC) issued an operating license in 1996, TVA deferred completion of Unit 2. TVA has now restarted construction and the NRC has resumed its operating license review. Conditions have changed over this time period including the integrity of what is currently on site, the hydrology, ecology, population, waste management, costs, alternative energy technology options and the need for power.
5. Based on historical experience with nuclear reactors to date, I believe that these reactors are inherently dangerous. The reactor TVA intends to construct at this site has significant design flaws. The construction of this nuclear reactor so close to my home could pose a grave risk to my health and safety. In particular, I am concerned that if an accident involving atmospheric release of radiological material were to occur I could be killed or become very ill. Therefore I am greatly concerned that Watts Bar Unit 2 should not be licensed unless it can be operated safely and without significant adverse environmental impacts.
6. Therefore, I have authorized the Southern Alliance for Clean Energy to represent my interests in this operating license proceeding for TVA's Watts Bar Unit 2.

Sandra L. Kurtz
(Signature)

Date 6/16/09

Eric L. Hambrick
exp. 4/15/2012



JUN 29 2009

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE SECRETARY

In the Matter of
Tennessee Valley Authority
Watts Bar Plant Unit 2

Docket No. 50-391

DECLARATION OF STANDING

Under penalty of perjury, Louise Gorenflo declares as follows:

1. My name is Louise Gorenflo. I am a member of the Southern Alliance for Clean Energy.

2. I live at 185 Hood Drive Crossville TN 38555

3. My home lies within 50 miles of the site in Rhea County, Tennessee where Tennessee Valley Authority (TVA) proposes to finish building and operate an additional reactor on the site of Watts Bar Unit 1 is located.

4. TVA originally submitted the application for Watts Bar Units 1 and 2 on June 30, 1976. Though TVA completed Unit 1 and the Nuclear Regulatory Commission (NRC) issued an operating license in 1996, TVA deferred completion of Unit 2. TVA has now restarted construction and the NRC has resumed its operating license review. Conditions have changed over this time period including the integrity of what is currently on site, the hydrology, ecology, population, waste management, costs, alternative energy technology options and the need for power.

5. Based on historical experience with nuclear reactors to date, I believe that these reactors are inherently dangerous. The reactor TVA intends to construct at this site has significant design flaws. The construction of this nuclear reactor so close to my home could pose a grave risk to my health and safety. In particular, I am concerned that if an accident involving atmospheric release of radiological material were to occur I could be killed or become very ill. Therefore I am greatly concerned that Watts Bar Unit 2 should not be licensed unless it can be operated safely and without significant adverse environmental impacts.

6. Therefore, I have authorized the Southern Alliance for Clean Energy to represent my interests in this operating license proceeding for TVA's Watts Bar Unit 2.

(Signature)

Louise Gorenflo

Date

6/26/09

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE SECRETARY

In the Matter of _____
Tennessee Valley Authority _____
Watts Bar Plant Unit 2 _____

)
)
) Docket No. 50-391
)
)

DECLARATION OF STANDING

I declare under penalty of perjury:

1. My name is Carol Kinnors. I am a member of the Tennessee Environmental Council.

2. I live at 1233 Cartwright Loop.

3. My home lies within 40 miles of the site in Rhea County, Tennessee where Tennessee Valley Authority (TVA) proposes to finish building and operate an additional reactor on the site of Watts Bar Unit 1 is located.

4. TVA originally submitted the application for Watts Bar Units 1 and 2 on June 30, 1976. Though TVA completed Unit 1 and the Nuclear Regulatory Commission (NRC) issued an operating license in 1996, TVA deferred completion of Unit 2. TVA has now restarted construction and the NRC has resumed its operating license review. Conditions have changed over this time period including the integrity of what is currently on site, the hydrology, ecology, population, waste management, costs, alternative energy technology options and the need for power.

5. Based on historical experience with nuclear reactors to date, I believe that these reactors are inherently dangerous. The reactor TVA intends to construct at this site has significant design flaws. The construction of this nuclear reactor so close to my home could pose a grave risk to my health and safety. In particular, I am concerned that if an accident involving atmospheric release of radiological material were to occur I could be killed or become very ill. Therefore I am greatly concerned that Watts Bar Unit 2 should not be licensed unless it can be operated safely and without significant adverse environmental impacts.

6. Therefore, I have authorized the Tennessee Environmental Council to represent my interests in this operating license proceeding for TVA's Watts Bar Unit 2.

Carol A Kinnors
(Signature)

Date June 30, 2009

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE SECRETARY

In the Matter of
Tennessee Valley Authority
Watts Bar Plant Unit 2

Docket No. 50-391

DECLARATION OF STANDING

I declare under penalty of perjury:

1. My name is yvonne Derrickson
I am a member of the Tennessee Environmental Council.

2. I live at 5604 river glade
drive

3. My home lies within 50 miles of the site in Rhea County, Tennessee where Tennessee Valley Authority (TVA) proposes to finish building and operate an additional reactor on the site of Watts Bar Unit 1 is located.

4. TVA originally submitted the application for Watts Bar Units 1 and 2 on June 30, 1976. Though TVA completed Unit 1 and the Nuclear Regulatory Commission (NRC) issued an operating license in 1996, TVA deferred completion of Unit 2. TVA has now restarted construction and the NRC has resumed its operating license review. Conditions have changed over this time period including the integrity of what is currently on site, the hydrology, ecology, population, waste management, costs, alternative energy technology options and the need for power.

5. Based on historical experience with nuclear reactors to date, I believe that these reactors are inherently dangerous. The reactor TVA intends to construct at this site has significant design flaws. The construction of this nuclear reactor so close to my home could pose a grave risk to my health and safety. In particular, I am concerned that if an accident involving atmospheric release of radiological material were to occur I could be killed or become very ill. Therefore I am greatly concerned that Watts Bar Unit 2 should not be licensed unless it can be operated safely and without significant adverse environmental impacts.

6. Therefore, I have authorized the Tennessee Environmental Council to represent my interests in this operating license proceeding for TVA's Watts Bar Unit 2.

yvonne Derrickson Date 6-29-9
(Signature)

BEFORE THE SECRETARY

In the Matter of
Tennessee Valley Authority
Watts Bar Plant Unit 2

Docket No. 50-391

I declare under penalty of perjury:

2. I live at 446 Lantana Rd, Crossville TN

4. TVA originally submitted the application for Watts Bar Units 1 and 2 on June 30, 1976. Though TVA completed Unit 1 and the Nuclear Regulatory Commission (NRC) issued an operating license in 1996, TVA deferred completion of Unit 2. TVA has now restarted construction and the NRC has resumed its operating license review. Conditions have changed over this time period including the integrity of what is currently on site, the hydrology, ecology, population, waste management, costs, alternative energy technology options and the need for power.

6. Therefore, I have authorized the Tennessee Environmental Council to represent my interests in this operating license proceeding for TVA's Watts Bar Unit 2.

Jean Cheely Date July 1, 2009
(Signature)

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE SECRETARY

In the Matter of
Tennessee Valley Authority
Watts Bar Plant Unit 2

Docket No. 50-391

DECLARATION OF STANDING

Under penalty of perjury, William F. Reynolds declares as follows:

1. My name is William Frederick Reynolds. I am a member of the Sierra Club (Lifetime member), Chair of Nuclear Committee, TN Chapter

2. I live at 3529 Dell Trail, Chattanooga, TN 37411.

3. My home lies within 50 miles of the site in Rhea County, Tennessee where Tennessee Valley Authority (TVA) proposes to finish building and operate an additional reactor where the site of Watts Bar Unit 1 is located.

4. TVA originally submitted the application for Watts Bar Units 1 and 2 on June 30, 1976. Though TVA completed Unit 1 and the Nuclear Regulatory Commission (NRC) issued an operating license in 1996, TVA deferred completion of Unit 2. TVA has now restarted construction and the NRC has resumed its operating license review. Conditions have changed over this time period including the integrity of what is currently on site, the hydrology, ecology, population, waste management, costs, alternative energy technology options and the need for power.

5. Based on historical experience with nuclear reactors to date, I believe that these reactors are inherently dangerous. The reactor TVA intends to construct at this site has significant design flaws. The construction of this nuclear reactor so close to my home could pose a grave risk to my health and safety. In particular, I am concerned that if an accident involving atmospheric release of radiological material were to occur I could be killed or become very ill. Therefore I am greatly concerned that Watts Bar Unit 2 should not be licensed unless it can be operated safely and without significant adverse environmental impacts.

6. Therefore, I have authorized the Sierra Club to represent my interests in this operating license proceeding for TVA's Watts Bar Unit 2.

(Signature) [Signature] Date 07-07-2009

Carla Morgan
7-7-2009



My Commission Expires 9-19-2012

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE SECRETARY

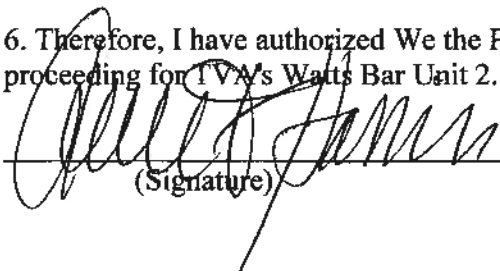
In the Matter of _____
Tennessee Valley Authority _____
Watts Bar Plant Unit 2 _____

Docket No. 50-391

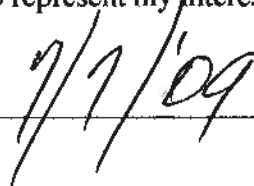
DECLARATION OF STANDING BY ANN P. HARRIS

Under penalty of perjury, Ann P. Harris declares as follows:

1. My name is Ann P. Harris. I am a member of We the People, Inc., Sierra Club and the Sierra Club's National Radiation Committee.
2. I live at 341 Swing Loop, Rockwood, TN 37854
3. My home lies within 14 to 17 miles of the site in Rhea County, Tennessee where Tennessee Valley Authority (TVA) proposes to finish building and operate an additional reactor on the site where Watts Bar Unit 1 is located. I also own property on the east bank of the Tennessee River in Roane County, where my disabled Mother lives. The entire property where my Mother lives lies within the Watts Bar evacuation zone.
4. TVA originally submitted the operating license application for Watts Bar Units 1 and 2 on June 30, 1976. Though TVA completed Unit 1 and the Nuclear Regulatory Commission (NRC) issued an operating license in 1996, TVA deferred completion of Unit 2. TVA has now restarted construction and the NRC has resumed its operating license review. Conditions have changed over this time period including the integrity of what is currently on site, the hydrology, ecology, population, new schools, waste management, costs, alternative energy technology options and the need for power.
5. Based on historical experience with nuclear reactors to date, I believe that these reactors are inherently dangerous. The reactor TVA intends to construct at this site has significant design flaws. The construction of this nuclear reactor so close to my home could pose a grave risk to my health and safety. In particular, I am concerned that if an accident involving atmospheric release of radiological material were to occur I, or my family, could be killed or become very ill. Therefore I am greatly concerned that Watts Bar Unit 2 should not be licensed unless it can be operated safely and without significant adverse environmental impacts.
6. Therefore, I have authorized We the People, Inc. to represent my interests in this operating license proceeding for TVA's Watts Bar Unit 2.


(Signature)

Date



UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE SECRETARY

In the Matter of
Tennessee Valley Authority
Watts Bar Plant Unit 2

Docket No. 50-391

DECLARATION OF STANDING

Under penalty of perjury, Dennis Gregg declares as follows:

1. My name is Dennis Gregg. I am a member of the Blue Ridge Environmental Defense League.

2. I live at 175 Hood Dr, Crossville, TN 38555.
Physical (or 911) address

3. My home lies within 30 miles of the site in Rhea County, Tennessee where Tennessee Valley Authority (TVA) proposes to finish building and operate an additional reactor on the site of Watts Bar Unit 1 is located.

4. TVA originally submitted the application for Watts Bar Units 1 and 2 on June 30, 1976. Though TVA completed Unit 1 and the Nuclear Regulatory Commission (NRC) issued an operating license in 1996, TVA deferred completion of Unit 2. TVA has now restarted construction and the NRC has resumed its operating license review. Conditions have changed over this time period including the integrity of what is currently on site, the hydrology, ecology, population, waste management, costs, alternative energy technology options and the need for power.

5. Based on historical experience with nuclear reactors to date, I believe that these reactors are inherently dangerous. The reactor TVA intends to construct at this site has significant design flaws. The construction of this nuclear reactor so close to my home could pose a grave risk to my health and safety. In particular, I am concerned that if an accident involving atmospheric release of radiological material were to occur I could be killed or become very ill. Therefore I am greatly concerned that Watts Bar Unit 2 should not be licensed unless it can be operated safely and without significant adverse environmental impacts.

6. Therefore, I have authorized the Blue Ridge Environmental Defense League to represent my interests in this operating license proceeding for TVA's Watts Bar Unit 2.

Dennis Gregg
(Signature)

Date 7/9/09

INTERAGENCY AGREEMENT
WATTS BAR RESERVOIR PERMIT COORDINATION

Reimb

"Coord Permit Appl's,
Watts Bar

- I. PURPOSE AND SCOPE
 - II. AUTHORITIES
 - III. LIMITS OF AREA TO BE CONSIDERED
 - IV. RESPONSIBILITIES
 - A. U.S. TENNESSEE VALLEY AUTHORITY
 - B. U.S. ARMY CORPS OF ENGINEERS
 - C. DEPARTMENT OF ENERGY
 - D. ENVIRONMENTAL PROTECTION AGENCY
 - E. TENNESSEE DEPARTMENT OF HEALTH AND ENVIRONMENT
 - V. DURATION OF THIS AGREEMENT AND SIGNATURE
- ATTACHMENT 1.....LOCATION MAP
- ATTACHMENT 2.....ACTION SCREENING CATEGORIES
- ATTACHMENT 3.....ABBREVIATIONS

B Feb 91
Multi-Agency Signatures
4-Agency on pg 7

INTERAGENCY AGREEMENT
WATTS BAR RESERVOIR PERMIT COORDINATION

AMONG THE U.S. TENNESSEE VALLEY AUTHORITY, NASHVILLE DISTRICT
U.S. CORPS OF ENGINEERS, U.S. DEPARTMENT OF ENERGY, U.S.
ENVIRONMENTAL PROTECTION AGENCY, AND THE TENNESSEE DEPARTMENT OF
HEALTH AND ENVIRONMENT*

I. PURPOSE AND SCOPE

The purpose of this agreement is to establish a procedure for the interagency coordination and review of permitting and other use authorization activities by the U. S. Army Corps of Engineers, Nashville District, and U.S. Tennessee Valley Authority which could result in the disturbance, resuspension, removal and/or disposal of contaminated sediments or potentially contaminated sediments in the Watts Bar Reservoir. This agreement identifies the cooperative efforts of the U.S. Department of Energy (DOE), U.S. Environmental Protection Agency (EPA), U.S. Army Corps of Engineers Nashville District (USACE), U.S. Tennessee Valley Authority (TVA), and The Tennessee Department of Health and Environmental (TDHE) to achieve this goal. This Interagency Agreement relates only to the issues associated with the contaminated or potentially contaminated sediments resulting from the DOE Operations at Oak Ridge, Tennessee. It does not suspend or void other permit review and coordination agreements that currently exist between the participants, nor does it preempt or limit in any way the authority of TDHE, EPA, TVA, USACE, or DOE for those matters which are under their regulatory or statutory jurisdiction or authorization. This agreement does not address, nor is it intended to address, any remediation responsibility of any of the parties. The agreement becomes effective when signed by all parties.

* Executive Order No. 42 of February 4, 1991 transferred the environmental functions of the Department of Health and Environment to the Department of Conservation. All references to TDHE throughout this agreement should be understood to refer to the Department of Conservation and any successor agency that houses these environmental Divisions.

II. AUTHORITIES

- A. Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 403).
- B. Section 404 of the Clean Water Act (33 U.S.C. 1344).
- C. Section 26a of the Tennessee Valley Authority Act of 1933 (16 U.S.C. 831y-1).
- D. Sections 4(k) and 31 of the Tennessee Valley Authority Act of 1933, as amended, Public Law 87-852, Public Law 93-153, the Federal Property and Administration Services Act of 1949, and other TVA land use agreements that can be authorized under the TVA Act.
- E. The Tennessee Water Quality Control Act of 1977 including 1987 amendments (69-3-107).

III. LIMITS OF AREA TO BE CONSIDERED BY THIS AGREEMENT

This agreement applies only to those portions of Watts Bar Reservoir which are subject or may potentially be subject to sediment contamination by the DOE Operations at Oak Ridge Tennessee. Specifically the areal extent of contaminated or potentially contaminated sediments has been initially identified to include the mainstream, embayments and impounded tributaries of Watts Bar Reservoir as follows:

- A. Tennessee River from Mile 529.9 (Watts Bar Dam) to Mile 569.0 (Webster Bluff Light).
- B. Clinch River from Mile 0.0 (Mouth at Tennessee River Mile 567.5) to Clinch River Mile 23.1 (Melton Hill Dam).
- C. Emory River from Mile 0.0 (Mouth at Clinch River Mile 4.3) to Mile 5.2 (downstream from the confluence of the Little Emory River).

The areal extent may be redefined (expanded or reduced) as additional information becomes available during the DOE Remedial Investigation/Feasibility Study of Watts Bar Reservoir. (See Attachment 1 for a location map identifying the initial areal extent of this agreement.)

IV. RESPONSIBILITIES

GENERAL:

The agreement will be administered by a Working Group (WG) consisting of a designated member (and alternate) from each participating agency. The Group will be chaired by the TDHE.

Upon the identification of the individual agency members, the Group shall meet and develop its internal operating and followup procedures, and coordination contacts.

The WG shall develop a screening list of all actions permitted or authorized under the regulatory authority of the USACE and TVA to identify those specific actions which can be categorized as having No Significant Sediment Disturbance (NSSD), Marginal Sediment Disturbance (MSD), or Potential Major Sediment Disturbance (PMSD), with respect to contaminated sediment issues within the designated area of Watts Bar Reservoir. The WG shall periodically review and update the screening lists to determine if, based on operating experience or additional information, changes are warranted in specific action categories. (See Attachment 2 for the initial screening lists.)

All actions identified in the NSSD Category will be processed under the existing USACE and TVA review and coordination procedures without further consideration or review relating to the sediment contamination issues addressed in this agreement. Those actions within the MSD and the PMSD categories will be subject to a case by case review under this agreement prior to a final decision by USACE and TVA.

Specific agency responsibilities under this agreement are identified as follows:

A. U.S. TENNESSEE VALLEY AUTHORITY

1. Review all permit and use applications to determine the appropriate action category. For those applications which under existing processing procedures would involve coordination with the USACE, contact the USACE to solicit their concurrence with the screening category. For those applications involving actions within the NSSD category proceed with the application processing and appropriate action in accordance with TVA's existing established review and coordination procedures.
2. For those applications which would be categorized as MSD or PMSD actions provide a copy of the application to each agency WG member for review and a determination of an appropriate recommendation from their agency's perspective.

3. In consultation with the USACE develop and implement a procedure to provide notification to the applicant of the action category status of their application and to the extent possible the time period which may be required to process or to determine the acceptability of the proposed action.
4. Request the WG chairman to develop a recommendation with respect to the sediment contamination issue associated with individual MSD or PMSD actions.
5. Upon receipt of the recommendation complete the processing of the application.

B. U.S. ARMY CORPS OF ENGINEERS (NASHVILLE DISTRICT)

- 1.. Review all permit applications to determine the appropriate screening category. Forward copies of the applications to TVA to solicit their concurrence with the screening categorization. For those applications which are within the NSSD category proceed with the application processing and appropriate action in accordance with USACE's existing established review and coordination procedures.
2. In consultation with TVA develop and implement a procedure to provide notification to the applicant of the action category status of their application and to the extent possible the time period which may be required to process or to determine the acceptability of the proposed action.
3. Upon receipt of the recommendation complete the processing of the application.

C. DEPARTMENT OF ENERGY

1. Upon receipt from TVA of a copy of an application for a proposed action in the MSD or PMSD category, review DOE's existing sediment data base and provide copies of all available data in the vicinity of the proposed action to each member.
2. As requested by the chairman, acquire appropriate sediment data where existing data are not adequate or available in the vicinity of the proposed action. Provide each member an estimate of the date when the data can be available and copies of the data when available.
3. As requested by the chairman, provide appropriate technical assistance, including risk analysis, to all parties.

D. ENVIRONMENTAL PROTECTION AGENCY

1. Upon receipt from TVA of a copy of an application within the MSD or PMSD category, in conjunction with the existing available sediment data to be provided by DOE, review the application and provide each member with a recommendation for appropriate action.

E. TENNESSEE DEPARTMENT OF HEALTH AND ENVIRONMENT:

1. Coordinate Group efforts and serve as chairman of the Group.
2. Upon receipt from TVA of a copy of an application within the MSD or PMSD categories, in conjunction with the existing available sediment data to be provided by DOE, review the application and provide each member with a recommendation for appropriate action.
3. Identify and provide guidance to the members on specific additional data needs for the proposed actions.
4. Determine the adequacy of existing or acquired data in characterizing the sediments at the location of a proposed permit action.
5. In consultation with EPA, request DOE to collect sediment data in the vicinity of proposed actions where existing data is determined to be inadequate or not available.
6. Provide the applicant, and WG members with a final recommended action with respect to any application within the MSD or PMSD categories.

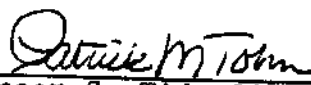
V. DURATION OF THIS AGREEMENT

This agreement shall become effective upon the signature of the last party.

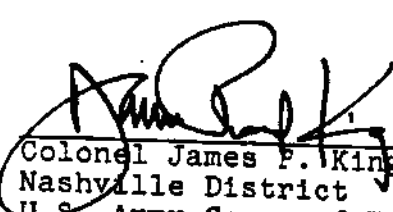
This agreement shall remain in effect until such time as the participants mutually agree to its termination. Any party can terminate its participation in the agreement upon 30 day written notice to all other parties.

Proposals to amend this agreement shall be made in writing to all participating parties.

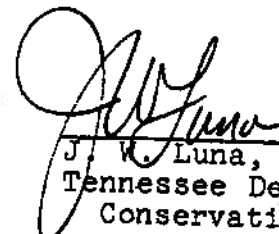
NOW, THEREFORE, the undersigned representative of each party hereby certifies that he is fully authorized and does hereby enter into the terms and conditions of this Agreement.


Greer C. Tidwell, Regional
Administrator, Region IV
U.S. Environmental Protection Agency


Date: 2-28-91


Colonel James P. King
Nashville District
U.S. Army Corps of Engineers


Date: 2-25-91


J. W. Luna, Commissioner
Tennessee Department of
Conservation

Date: 2/25/91


W. F. Willis
Vice President, Resource Group
and Chief Executive Officer
U.S. Tennessee Valley
Authority

Date: 2-26-91


Joe LaGrone, Manager
Oak Ridge Operations,
U.S. Department of Energy

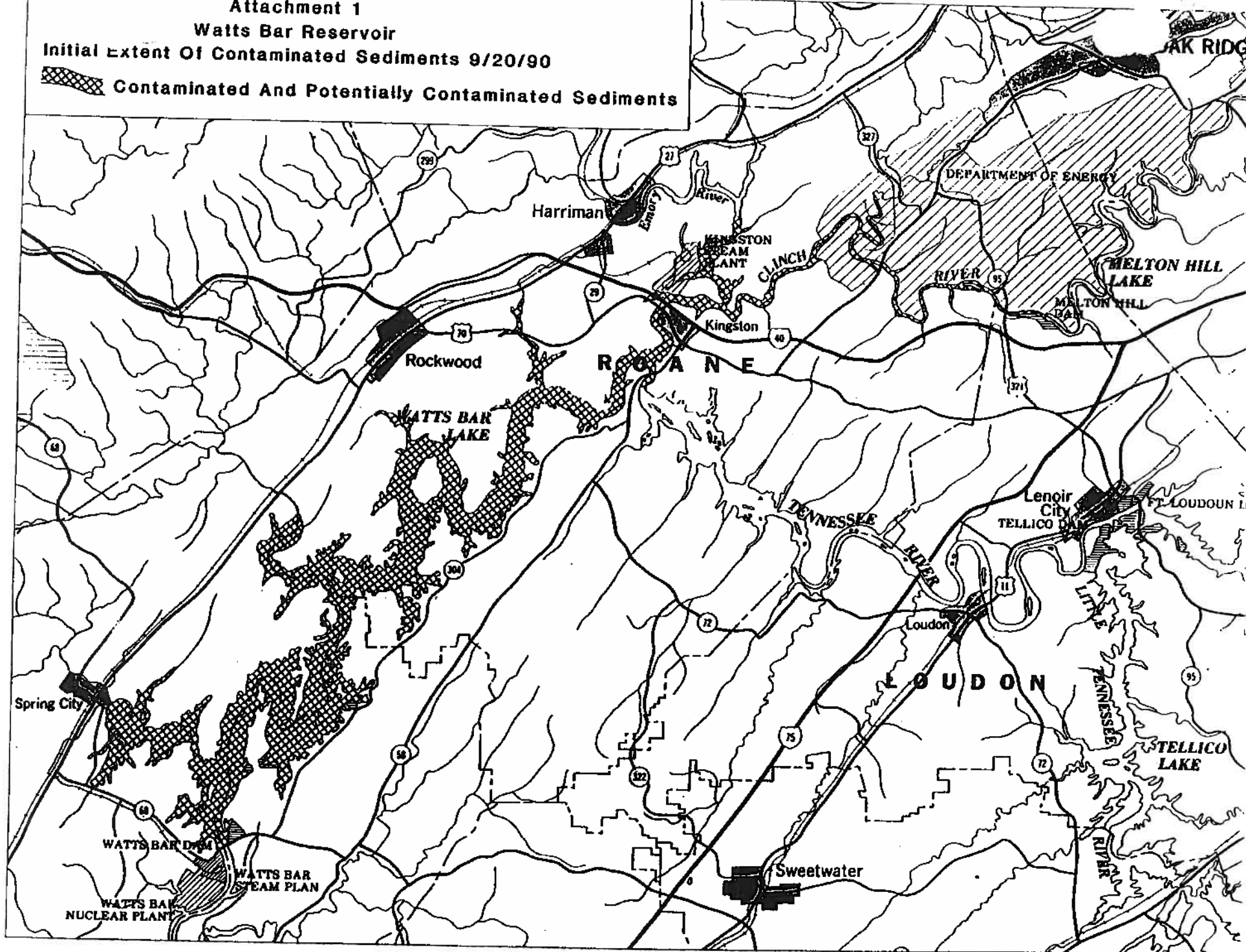
Date: 2-26-91

UST28DOE

Attachment 1
Watts Bar Reservoir
Initial Extent Of Contaminated Sediments 9/20/90



Contaminated And Potentially Contaminated Sediments



ATTACHMENT 2

ACTION SCREENING CATEGORIES
FOR THE
WATTS BAR RESERVOIR
CONTAMINATED SEDIMENT AREA

NO SIGNIFICANT SEDIMENT DISTURBANCE

Aerial Crossing - Cable TV
Aerial Crossing - Electric
Aerial Crossing - Gaging Station
Aerial Crossing - Other
Aerial Crossing - Sewer
Aerial Crossing - Telephone
Aerial Crossing - Water
Agricultural License
Beach
Boat Launching Ramp - Concrete (push in slab within drawdown zone
or no excavation and site preparation below elevation 741)
Boat Launching Ramp - Gravel
Boat Lift
Boat Slips - Fixed (supports driven)
Boat Slips - Fixed - Private (support holes dug above elevation
731)
Boat Slips - Fixed and Floating (supports driven)
Boat Slips - Fixed and Floating - Private (support holes dug
above elevation 731)
Boat Slips - Floating
Boathouse - Floating
Breakwater - Fixed - Private (supports driven or support holes
dug above elevation 731)
Breakwater - Floating
Bridge - Pedestrian (supports above elevation 731)
Building - Open to the Elements (i.e., airplane hangars, storage
lockers, open shelters, etc.)
Building - Other (i.e., office space, storage, restaurant,
dwelling, etc.)
Buoy
Buoy Line - Swimming Area
Closed Heating System
Concession Building
Dock - Fixed - Private (supports driven or support holes dug
above elevation 731)
Dock - Fixed and Floating - Private (supports driven or support
holes dug above elevation 731)
Dock - Floating
Fence (above elevation 731)
Fish Attractors
Guard Posts
Harbor Limits

NO SIGNIFICANT SEDIMENT DISTURBANCE
(CONTINUED)

Land conveyances above normal pool
Marine Railway (above elevation 731)
Marine Service Station
Minor Grading (above elevation 741)
Mooring Post (driven)
Mooring Post - Private (holes dug above elevation 731)
Osprey Nest Platforms (supports driven)
Paved or sodded drainage ditches
Picnic tables, benches, grills
Play Facilities (above elevation 731)
Power and waterlines to serve water use facilities moored or attached to shoreline
Removal of undesirable growth
Retaining wall (within 2' of the shoreline, footer elevation above elevation 735, and constructed in the dry)
Retaining Wall Faced w/Riprap (within 2' of the shoreline, footer elevation above 735, and constructed in the dry)
Riprap (no site preparation - direct dump)
Roads, including turnarounds, serving water use facilities
Seeding and sodding for lawns
Septic tank disposal fields
Sewage Pumping Station
Ski Jump
Slalom Course
Sign
Terraces, covered patios, and gazebos
Walkways, steps, landings
Water intake - Fixed (private noncommercial with intake port at least 1' above the bottom sediments)

NOTE: Excavated material from support holes deposited at site.

NOTE: Actions within the No significant Sediment Disturbance Category can be processed within the existing review and coordination agreements.

NOTE: Key Reservoir Elevations
Summer pool elevation 741' msl
Winter pool elevation 735' msl
Minimum elevation for sediment disturbance as determined by working group 731' msl

ACTION SCREENING CATEGORIES
FOR THE
WATTS BAR RESERVOIR
CONTAMINATED SEDIMENT AREA

MARGINAL SEDIMENT DISTURBANCE

Boat slips - Fixed - Covered (support holes dug) - Commercial
Boat Slips - Fixed - Open (support holes dug) - Commercial
Boat Slips - Fixed and Floating (support holes dug) - Commercial
Boathouse - Fixed (support holes dug) - Commercial
Breakwater (support holes dug) - Commercial
Bridge - Vehicular
Bridge with Approach Fills
Culvert - Other
Culvert - Roadway
Dock - Fixed (support holes dug) - Commercial
Dock - Fixed and Floating (support holes dug) - Commercial
Dredging/Excavation - Private (above elevation 735 and conducted in the dry)
Fill - Causeway/Roadway
Fill - Other
Marine Railway (below elevation 731)
Monitoring Station
Mooring Posts (holes dug) - Commercial
Mussel Cultural Raft
Retaining Wall (other)
Retaining Wall Faced w/Riprap (other)
Water Intake - Floating
Osprey Nest Platforms (holes dug) (below elevation 731)
Riprap (prepared site)

NOTE: Actions in the Marginal Sediment Disturbance category must be reviewed under the Interagency Agreement Watts Bar Reservoir Permit Coordination

NOTE: Key Reservoir Elevations
Summer pool elevation 741' msl
Winter pool elevation 735' msl
Minimum elevation for sediment disturbance as determined by working group 731' msl

ACTION SCREENING CATEGORIES
FOR THE
WATTS BAR RESERVOIR
CONTAMINATED SEDIMENT AREA

POTENTIAL MAJOR SEDIMENT DISTURBANCE

Barge Terminal - Loading and Unloading Facilities
Barge Terminal - Loading Facilities
Barge Terminal - Mooring Cells
Barge Terminal - Other
Barge Terminal - Unloading Facilities
Dam/Weir - Impounds Water
Dredging/Excavation - Private (below elevation 735)
Dredging/Excavation - Commercial Navigation Channel Maintenance
Levee/Dike - Structure to keep water off of an area
Mooring Cells/Dolphins/Deadmen Anchors - Fleeting Area
Mooring Cells/Dolphins/Deadmen Anchors - Other
Outfall
Submarine Crossing - Cable TV
Submarine Crossing - Other
Submarine Crossing - Petroleum
Submarine Crossing - Sewer
Submarine Crossing - Telephone
Submarine Crossing - Water
Water Intake - Fixed (commercial, industrial, municipal, and
agricultural irrigation)

NOTE: Actions in the Potential Major Sediment Category must
be reviewed under the Interagency Agreement Watts Bar
Reservoir Permit Coordination

NOTE: Key Reservoir Elevations
Summer pool elevation 741' msl
Winter pool elevation 735' msl
Minimum elevation for sediment disturbance as
determined by Working Group 731' msl

ATTACHMENT 3

ABBREVIATIONS

DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
USACE	U.S. Army Corps of Engineers
TVA	U.S. Tennessee Valley Authority
TDHE	Tennessee Department of Health and Environment
TDC	Tennessee Department of Conservation
WG	Working Group (DOE, EPA, USACE, TVA, TDHE)
NSSD	No significant Sediment Disturbance
MSD	Marginal Sediment Disturbance
PMSD	Potential Major Sediment Disturbance

July 10, 2009

**UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
BEFORE THE SECRETARY**

In the Matter of

Tennessee Valley Authority

(Watts Bar Unit 2)

Docket No. 50-391

**DECLARATION OF DR. EDWIN S. LYMAN
IN SUPPORT OF PETITIONERS' CONTENTIONS**

Under penalty of perjury,

I, Dr. Edwin S. Lyman, declare as follows:

1. I am a Senior Scientist with the Global Security Program at the Union of Concerned Scientists, 1825 K St, NW, Suite 800, Washington, D.C. 20006. My education and experience are described in my curriculum vita, which is included as an attachment to my declaration.

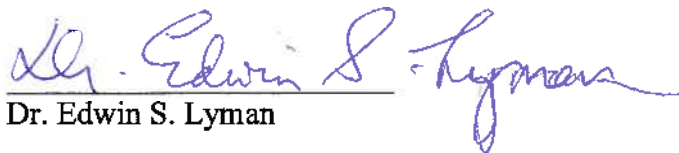
2. I am an expert in the technical analysis of safety, security and environmental issues related to nuclear facilities. I hold a Ph.D., a master of science degree, and a bachelor's degree in physics. For over fifteen years, I have conducted research on security and environmental issues associated with the management of nuclear materials and the operation of nuclear power plants. My research has included the safety and environmental risks posed by operation of nuclear power plants, including Watts Bar and other nuclear power plants of similar designs. I have also published articles on this topic. A list of my publications is included in my C.V.

3. I am familiar with the Watts Bar Unit 2 Severe Accident Management Alternatives Analysis submitted to the NRC by the Tennessee Valley Authority in support of its application to operate the Watts Bar Unit 2 nuclear plant. I am also familiar with publicly available documents related to Generic Safety Issue 189, "Susceptibility of Ice Condenser and Mark III Containments to Early Failure From Hydrogen Combustion During a Severe Accident." I am generally familiar with NRC technical studies of accident risks posed by nuclear power plants and their spent fuel, as well as NRC policies and regulations with respect to the protection of nuclear facilities against intentional attack.

4. I am familiar with the MACCS2 radiological consequence assessment software used by the Tennessee Valley Authority to prepare the Severe Accident Mitigation Alternatives Analysis in its Final Supplemental Environmental Impact Statement ("FSEIS") regarding the proposed operation of Watts Bar Unit 2. I have used this code

extensively and have published papers in technical journals based on these results. In 1998, I discovered and reported to the code manager a significant error in the software that had resulted in overestimates of latent cancer fatalities under certain circumstances, which was subsequently fixed.

5. I am responsible for the factual content and expert opinions expressed in Petitioners' contentions regarding the inadequacy of TVA's SAMA analysis to satisfy NRC regulations for the implementation of the National Environmental Policy Act. The facts presented in those contentions are true and correct to the best of my knowledge, and the opinions expressed therein are based on my best professional judgment.


Dr. Edwin S. Lyman

July 10, 2009

Edwin Stuart Lyman
Curriculum Vitæ

Education

Ph.D, Cornell University, Theoretical Physics, August 1992.
M.S., Cornell University, Physics, January 1990.
A.B., *summa cum laude*, New York University, Physics, June 1986; Phi Beta Kappa.

Professional Experience

May 1, 2003 – Present: Senior Staff Scientist, Union of Concerned Scientists.

June 2002 – April 2003: President, Nuclear Control Institute, Washington, D.C.

July 1995 – May 2002: Scientific Director, Nuclear Control Institute, Washington, D.C.

August 1992 – June 1995: Postdoctoral research associate, Center for Energy and Environmental Studies, Princeton University, Princeton, NJ.

Spring 1995: Preceptor for Environmental Studies 302, "Perspectives on Environmental Issues: Values and Policies."

Spring 1994: Lecturer, Woodrow Wilson School. Preceptor for WWS 304, "Science, Technology and Public Policy."

July 1988 – June 1992: Graduate research assistant, Newman Laboratory of Nuclear Studies, Cornell University, Ithaca, NY. Conducted thesis research on high-energy physics under the supervision of Prof. S.H.-H. Tye.

August 1986–June 1988: Andrew D. White Graduate Fellow, Physics, Cornell University.

Publications

E. Lyman, "Thirty Years after TMI: Five Continuing Vulnerabilities," *Bulletin of the Atomic Scientists*, March 23, 2009.

E. Lyman, "Making Domestically Produced Medical Isotopes a National Priority," *Bulletin of the Atomic Scientists*, December 18, 2008.

E. Lyman, "Can Nuclear Plants be Safer?" *Bulletin of the Atomic Scientists*, September/October 2008, 34-37.

E. Lyman and F. von Hippel, "Reprocessing Revisited: The International Dimensions of the Global Nuclear Energy Partnership," *Arms Control Today*, April 2008, 6-14.

E. Lyman and D. Lochbaum, "Protecting Vital Targets: Nuclear Power Plants," in *Homeland Security: Protecting America's Targets, Vol. III* (J. Forest, ed.), Praeger, Westport, CT, 2006, 157-173.

J. Beyea, E. Lyman and F. von Hippel, "Damages from a Major Release of ^{137}Cs Into the Atmosphere of the United States," *Science and Global Security* **12** (2004) 125-136.

G. Bunn, C. Braun, A. Glaser, E. Lyman and F. Steinhausler, "Research Reactor Vulnerability to Sabotage by Terrorists," *Science and Global Security* **11** (2003) 85-107.

D. Hirsch, D. Lochbaum and E. Lyman, "The NRC's Dirty Little Secret," *Bulletin of the Atomic Scientists* (May/June 2003).

R. Alvarez, J. Beyea, K. Janberg, J. Kang, E. Lyman, A. Macfarlane, G. Thompson and F. von Hippel, "Reducing the Hazards from Stored Spent Power-Reactor Fuel in the United States," *Science and Global Security* **11** (2003) 1-51.

E. Lyman, "Revisiting Nuclear Power Plant Safety" (letter), *Science* 299 (2003), 202.

E. Lyman, "The Limits of Technical Fixes," in *Nuclear Power and The Spread of Nuclear Weapons: Can We Have One Without the Other?* (P. Leventhal, S. Tanzer and S. Dolley, eds.), Brassey's, Washington, DC, 2002, 167-182.

E. Lyman, "The Pebble-Bed Modular Reactor: Safety Issues," *Physics and Society*, American Physical Society, October 2001.

E. Lyman, "Public Health Risks of Substituting Mixed-Oxide for Uranium Fuel in Pressurized Water Reactors," *Science and Global Security* 9 (2001), 1.

E. Lyman and S. Dolley, "Accident Prone," *Bulletin of the Atomic Scientists*, March/April 2000, 42.

E. Lyman and H. Feiveson, "The Proliferation Risks of Plutonium Mines," *Science and Global Security* **7** (1998), 119.

E. Lyman and P. Leventhal, "Bury the Stuff [Weapons Plutonium]," *Bulletin of the Atomic Scientists*, March/April 1997, 45.

E. Lyman, "Weapons Plutonium: Just Can It," *Bulletin of the Atomic Scientists*, November/December 1996, 48.

F. von Hippel and E. Lyman, "Appendix: Probabilities of Different Yields," addendum to J. Mark, "Explosive Properties of Reactor-Grade Plutonium," *Science and Global Security* **4** (1993),

125.

F. Berkhout, A. Diakov, H. Feiveson, H. Hunt, E. Lyman, M. Miller, and F. von Hippel, "Disposition of Separated Plutonium," *Science and Global Security* **3** (1993), 161.

E. Lyman, F. Berkhout and H. Feiveson, "Disposing of Weapons-Grade Plutonium," *Science* **261** (1993) 813.

P. Argyres, E. Lyman and S.H.-H. Tye, "Low-Lying States of the Six-Dimensional Fractional Superstring," *Phys. Rev. D* **46** (1992) 4533.

S.-w. Chung, E. Lyman and S.H.-H. Tye, "Fractional Supersymmetry and Minimal Coset Models in Conformal Field Theory," *Int. J. Mod. Phys A* **7** (1992) 3337.

Selected Reports

L. Gronlund, D. Lochbaum and E. Lyman, "Nuclear Power in a Warming World," Union of Concerned Scientists, December 2007.

E. Lyman (with M. Schneider et al.), "Residual Risk: An Account of Events in Nuclear Power Plants Since the Chernobyl Accident in 2006," commissioned by the Greens of the European Parliament, May 2007.

E. Lyman, "Chernobyl on the Hudson? The Health and Environmental Impacts of a Terrorist Attack at the Indian Point Nuclear Power Plant," commissioned by Riverkeeper, Inc., September 2004.

E. Lyman, "Safety Issues in the Sea Shipment of Vitrified High-Level Radioactive Wastes to Japan," report sponsored by the Nuclear Control Institute, Greenpeace International and Citizens' Nuclear Information Center Tokyo, December 1994.

E. Lyman, "Interim Storage Matrices for Excess Plutonium: Approaching the 'Spent Fuel Standard' Without the Use of Reactors," PU/CEES Report No. 286, Center for Energy and Environmental Studies, Princeton University, August 1994.

E. Lyman, "The Solubility of Plutonium in Glass," PU/CEES Report No. 275, Center for Energy and Environmental Studies, Princeton University, April 1993.

Selected Invited Talks and Testimony

“Reprocessing in the U.S.: Just Say No,” presentation at the NRC Fuel Cycle Information Exchange, June 25, 2009.

“Nuclear Concerns: Safety, Security, Waste and Proliferation,” presentation at the Nuclear Nonoperating Owners’ Group Conference, Baltimore, MD, April 23, 2009.

“NRC Regulation of the Nuclear Fuel Cycle: Safety and Security Concerns,” presentation at the NRC Regulatory Information Conference, March 11, 2009.

“UCS Views on Risk-Informed Regulation,” presentation at NRC Commission briefing on risk-informed regulation, February 4, 2009.

“Licensing Challenges for Fuel Cycle Facilities Under the Global Nuclear Energy Partnership,” U.S. Nuclear Regulatory Fuel Cycle Information Exchange, Rockville, MD, June 12, 2007.

“The ‘Nuclear Renaissance’ and the Spread of Nuclear Weapons,” American Physical Society Ohio Chapter Meeting, May 7, 2007.

“Recycling Nuclear Waste,” American Physical Society Annual April Meeting, Jacksonville, FL, April 15, 2007.

“The Security Imperative of Eliminating Commercial Use of HEU,” presentation to the Committee on Medical Isotope Production Without Highly Enriched Uranium, National Academy of Sciences, Washington, DC, February 15, 2007.

“Recycling Nuclear Waste,” Peace Studies Seminar, Cornell University, November 29, 2006.

“Nuclear Power and Nuclear Proliferation,” Citizens for Global Solutions conference, Washington, DC, November 13, 2006.

“Next-Generation Nuclear Plants: Safety and Security,” presented at “Is Nuclear Power a Solution to Global Warming and Rising Energy Prices?,” American Enterprise Institute conference, Washington, DC, October 6, 2006.

“Recycling Nuclear Waste: Technical Difficulties and Proliferation Concerns,” Physics Department Colloquium, Case Western Reserve University, Cleveland, OH, September 14, 2006.

“The Chernobyl Source Term: Implications for Nuclear Safety,” international conference “Chornobyl +20: Remembrance for the Future,” Kiev, Ukraine, April 23-25, 2006.

“Public Health Consequences of a Severe Accident or Attack at a Nuclear Plant,” Nuclear Policy Research Institute Conference on Nuclear Power and Global Warming, Airlie House, Warrenton, VA, November 7, 2005.

Testimony before the Subcommittee on Clean Air, Climate Change on Nuclear Safety, Committee on Environment and Public Works, United States Senate, May 26, 2005.

“Safeguarding the U.S. Plutonium Disposition Program Against Nuclear Terrorism,” Science and Global Security Program seminar, Woodrow Wilson School of Public and International Affairs, Princeton University, December 9, 2004.

“Status of the Security Regime for the U.S. Mixed-Oxide Fuel Program,” Managing the Atom Project seminar, Belfer Center for Science and International Affairs, Kennedy School of Government, Harvard University, November 2, 2004.

"U.S. Nonproliferation Policy, Plutonium Disposition and the Threat of Nuclear Terrorism," seminar on "Recycling Plutonium: Risks and Alternatives," sponsored by the Green Group, European Parliament, Brussels, Belgium, January 9, 2003.

"Current Status of the U.S. Plutonium Disposition Program," seminar, Princeton University Program on Science and Global Security, Princeton University, Princeton, NJ, June 12, 2002.

"Controlling Fissile and Radioactive Material," Public Health Summit on Weapons of Mass Destruction, sponsored by Physicians for Social Responsibility and the UCLA School of Public Health, Ackerman Hall, UCLA, Los Angeles, June 2, 2002.

"Assessing the U.S. Government Response to the Nuclear Terrorism Threat After 9/11," presentation to the Joint Atomic Energy Intelligence Committee, McLean, VA, May 9, 2002.

"Upgrading Physical Protection at Nuclear Facilities to Address New Threats," MIT Security Studies Seminar, MIT, Boston, MA, April 18, 2002.

"Perspectives on New Plant Licensing," presentation at the U.S. Nuclear Regulatory Commission Briefing on Readiness for New Plant Applications and Construction, Washington, DC, July 19, 2001.

"Regulatory Challenges for Future Nuclear Plant Licensing: A Public Interest Perspective," U.S. NRC Advisory Committee on Reactor Safeguards (ACRS) Workshop on New Nuclear Plant Licensing, Washington, DC, June 5, 2001.

"The Future of Nuclear Power: A Public Interest Perspective," 2001 Symposium of the Northeast Chapter of Public Utility Commissioners, Mystic, CT, May 21, 2001.

Statement at the U.S. Nuclear Regulatory Commission Briefing on Office of Nuclear Regulatory Research Programs and Performance, May 11, 2001.

"Barriers to Deployment of Micro-Nuclear Technology," presentation at the workshop on "New Energy Technologies: A Policy for Micro-Nuclear Technologies," James A. Baker III Institute for Public Policy, Rice University, Houston, TX, March 19-20, 2001.

"Aging Research and Public Confidence," presentation at the U.S. Nuclear Regulatory Commission 2001 Regulatory Information Conference (RIC), Washington, DC, March 14, 2001.

NRC Reactor Safeguards Activities," presentation at the U.S. Nuclear Regulatory Commission 2001 Regulatory Information Conference (RIC), Washington, DC, March 14, 2001.

"DOE's Nuclear Material Stabilization Approach: The Failure of Transparency," Embedded Topical Meeting on DOE Spent Nuclear Fuel and Fissile Material Management, American Nuclear Society Annual Meeting, San Diego, CA, June 2000.

"The Status of Reactor Safeguards Initiatives," presentation at the U.S. NRC 2000 Regulatory Information Conference, Washington, DC, March 29, 2000.

"Safety Questions Concerning MOX Fuel Use in Proposed U.S. Reactors," Sixth International Policy Forum on the Management and Disposition of Nuclear Weapons Materials, sponsored by Exchange/Monitor Publications, Washington, DC, June 1999.

"Transparency and Plutonium Disposition," ISIS Workshop on Comprehensive Controls on Plutonium and Highly Enriched Uranium: Long-Term Problems and Prospects for Solutions, sponsored by the Institute for Science and International Security, Washington, DC, June 1997.

"Ship Transportation of Radioactive Materials," presentation to the Marine Board of the National Research Council, U.S. National Academy of Sciences, Woods Hole, MA, June 20, 1996.

"The Importation and Storage of High-Level Radioactive Wastes at Rokkasho-Mura: Safety Concerns," presentation at the Public Forum on High-Level Nuclear Waste and Reprocessing, Aomori, Japan, April 16, 1996.

"Perspectives on U.S. Options for Disposition of Excess Plutonium," Third International Policy Forum on the Management and Disposition of Nuclear Weapons Materials, sponsored by Exchange/Monitor Publications, Landsdowne, VA, March 21, 1996.

"Addressing Safety Issues in the Sea Transport of Radioactive Materials," presentation to the Special Consultative Meeting of Entities Involved in the Marine Transport of Nuclear Materials

Covered by the INF Code," International Maritime Organization, London, March 4-6, 1996.

"Prospects and Unsolved Issues for Plutonium Immobilization," INESAP/IANUS/UNIDIR Fissile Cutoff Workshop, Palais des Nations, Geneva, June 1995.

"An Intermediate Solution for Plutonium from Dismantled Nuclear Warheads," Annual Meeting of the German Physical Society, Berlin, Germany, March 1995.

"The Sea Transport of High-Level Radioactive Waste: Environmental and Health Concerns," Channel Islands International Conference on Nuclear Waste, St. Helier, Jersey, United Kingdom, January 1995.

Conference Papers

E. Lyman, "Excess Plutonium Disposition: Requiem for a Dream," 49th Annual Meeting of the Institute of Nuclear Materials Management, Nashville, TN, July 2008.

E. Lyman, "Revising the Rules for Material Protection, Control and Accounting," 8th International Conference on Facility Operations – Safeguards Interface, Portland, OR, March 30 – April 4, 2008.

E. Lyman, "Regulatory Challenges Facing the Global Nuclear Energy Partnership," GLOBAL 2007 Conference, Boise, ID, September 2007.

E. Lyman, "Envisioning a World Without Uranium Enrichment," 48th Annual Meeting of the Institute of Nuclear Materials Management, Tucson, AZ, July 2007.

E. Lyman, "The Global Nuclear Energy Partnership: Will it Advance Nonproliferation or Undermine it?" 47th Annual Meeting of the Institute of Nuclear Materials Management, Nashville, TN, July 2006.

E. Lyman, "Can Nuclear Fuel Production in Iran and Elsewhere Be Protected Against Diversion?" paper presented at the Nonproliferation Policy Education Center/King's College-London Conference "After Iran: Safeguarding Peaceful Nuclear Energy," London, October 2-3, 2005.

E. Lyman, "The Erosion of Physical Protection Standards Under the MOX Fuel Program," 46th Annual Meeting of the Institute of Nuclear Materials Management, Phoenix, AZ, July 2005.

E. Lyman, "Extending the Foreign Spent Fuel Acceptance Program: Policy and Implementation Issues," 26th International Meeting on Reduced Enrichment for Research and Test Reactors, IAEA, Vienna, Austria, November 2004.

E. Lyman, "Using Bilateral Mechanisms to Strengthen Physical Protection Worldwide," 45th Annual Meeting of the Institute of Nuclear Materials Management, Orlando, FL, July 2004.

E. Lyman, "The Congressional Attack on RERTR," 25th International Meeting on Reduced Enrichment for Research and Test Reactors, RERTR-2003, Chicago, IL, October 2003.

E. Lyman, "Nuclear Plant Protection and the Homeland Security Mandate," 44th Annual Meeting of the Institute of Nuclear Materials Management, Phoenix, AZ, July 2003.

E. Lyman and A. Kuperman, "A Reevaluation of Physical Protection Standards for Irradiated HEU Fuel," 24th International Meeting on Reduced Enrichment for Research and Test Reactors, RERTR-2002, Bariloche, Argentina, November 2002.

E. Lyman, "Material Protection, Control and Accounting at the U.S. MOX Fuel Fabrication Plant: Merely and Afterthought?" 43rd Annual Meeting of the Institute of Nuclear Materials Management (INMM), Orlando, FL, June 2002.

E. Lyman, "Terrorism Threat and Nuclear Power: Recent Developments and Lessons to be Learned," Symposium on Rethinking Nuclear Energy and Democracy after 9/11, sponsored by PSR/IPPNW Switzerland, Basel, Switzerland, April 2002.

E. Lyman, remarks for Expert Panel on Advanced Reactors, Nuclear Safety Research Conference, U.S. Nuclear Regulatory Commission, Washington, DC, October 2001.

E. Lyman, "The Future of Immobilization Under the U.S.-Russian Plutonium Disposition Agreement," 42nd Annual Meeting of the Institute of Nuclear Materials Management (INMM), Indian Wells, CA, July 18, 2001.

E. Lyman, comments in *the Report of the Expert Panel on the Role and Direction of Nuclear Regulatory Research*, U.S. Nuclear Regulatory Commission, May 2001.

E. Lyman, "Can the Proliferation Risks of Nuclear Power be Made Acceptable?" Nuclear Control Institute 20th Anniversary Conference, Washington, DC, April 9, 2001.

E. Lyman and P. Leventhal, "Radiological Sabotage at Nuclear Power Plants: A Moving Target Set," 41st Annual Meeting of the INMM, New Orleans, LA, July 2000.

E. Lyman, "Comments on the Storage Criteria for the Storage and Disposal of Immobilized Plutonium," Proceedings of the Institute for Science and International Security Conference on "Civil Separated Plutonium Stocks --- Planning for the Future," March 14-15, 2000, Washington, DC, Isis Press, 135.

E. Lyman, "The Sea Shipment of Radioactive Materials: Safety and Environmental Concerns," Conference on Ultrahazardous Radioactive Cargo by Sea: Implications and Responses, sponsored by the Maritime Institute of Malaysia, Kuala Lumpur, Malaysia, October 1999.

E. Lyman, "A Critique of Physical Protection Standards for Irradiated Materials," 40th Annual Meeting of the INMM, Phoenix, AZ, July 1999.

E. Lyman, "DOE Reprocessing Policy and the Irreversibility of Plutonium Disposition," Proceedings of the 3rd Topical Meeting on DOE Spent Nuclear Fuel and Fissile Materials Management, American Nuclear Society, Charleston, SC, September 8-11, 1998, 149.

E. Lyman, "Japan's Plutonium Fuel Production Facility (PFPP): A Case Study of the Challenges of Nuclear Materials Management," 39th Annual Meeting of the INMM, Naples, FL, July 1998.

E. Lyman, "Safety Aspects of Unirradiated MOX Fuel Transport," Annex 2b of the *Comprehensive Social Impact Assessment of MOX Use in Light Water Reactors*, Citizens' Nuclear Information Center, Tokyo, November 1997.

E. Lyman, "Unresolved Safety Issues in the Storage and Transport of Vitrified High-Level Nuclear Waste," 38th Annual Meeting of the INMM, Phoenix, AZ, July 1997.

E. Lyman, "A Perspective on the Proliferation Risks of Plutonium Mines," proceedings of the Plutonium Stabilization and Immobilization Workshop, U.S. Department of Energy, Washington, DC, December 12-14, 1995, CONF-951259, p, 445.

E. Lyman, "Assessing the Proliferation and Environmental Risks of Partitioning-Transmutation," Fifth International Summer Symposium on Science and World Affairs, Cambridge, MA, USA, July 1993.

Op-Eds and Letters to the Editor

E. Lyman, "The Downside of Nuclear Energy," Washington Post, April 21, 2006.

E. Lyman, "Reprocessing Nuclear Waste: Forget It," Topeka Capital-Journal, December 24, 2005.

E. Lyman, "The Wrong Way to Get Cheap Electricity," Chicago Sun-Times, December 16, 2005.

E. Lyman, "Uranium on Campus," New York Times, August 23, 2004

L. Gronlund and E. Lyman, "Halting the Spread of Nuclear Arms," New York Times,

December 28, 2003.

E. Lyman, "Troubles at Indian Point," New York Times, January 25, 2003.

E. Lyman and P. Leventhal, "Nonessential Nukes" (op-ed), Washington Post, November 26, 2002.

P. Leventhal and E. Lyman, "Shipping Plutonium," New York Times, July 12, 2002.

E. Lyman, "Indian Point Reactor," New York Times, January 27, 2002.

E. Lyman, "Spent Nuclear Fuel," New York Times, June 3, 2001.

E. Lyman and P. Leventhal, "Better Plutonium Plan," New York Times, February 5, 1998.

E. Lyman, "A Safer Plutonium Plan," Washington Post, August 24, 1997.

P. Leventhal and E. Lyman, "Who Says Iraq Isn't Making a Bomb?" International Herald Tribune, November 2, 1995.

H. Feiveson and E. Lyman, "No Solution to the Plutonium Problem," Washington Post, July 29, 1994.

E. Lyman, "Getting Rid of Weapon Plutonium," *Bulletin of the Atomic Scientists*, July/August 1994.

July 11, 2009

**UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
BEFORE THE SECRETARY**

In the Matter of

Tennessee Valley Authority

(Watts Bar Unit 2)

Docket No. 50-391

**DECLARATION BY DR. ARJUN MAKHIJANI IN SUPPORT OF
PETITIONERS' CONTENTIONS**

Under penalty of perjury, I, Dr. Arjun Makhijani, declare as follows:

1. I am President of the Institute for Energy and Environmental Research (IEER). IEER has been doing nuclear-related studies for more than twenty years and is an independent non-profit organization located in Takoma Park, Maryland. Under my direction, IEER produces technical studies on a wide range of environmental issues to provide advocacy groups and policymakers with sound scientific information and analyses as applied to environmental and health protection and for the purpose of promoting the understanding and the democratization of science.

2. I have a Ph.D. (Engineering), granted by the Department of Electrical Engineering of the University of California, Berkeley, where I specialized in the application of plasma physics to controlled nuclear fusion. I also have a master's degree in electrical engineering from Washington State University, and a bachelor's degree in electrical engineering from the University of Bombay. I am qualified by training and experience as an expert in the fields of plasma physics, electrical engineering, nuclear engineering, and energy-related technology and policy issues. I have extensive professional experience and am qualified as an expert in radioactive waste disposal standards for protection of human health from radiation, and the relative costs and benefits of nuclear energy and other energy sources. I have served as a nuclear engineering expert witness in lawsuits and testified on a variety of issues including the release of radioactivity from nuclear facilities. A copy of my curriculum vita is attached.

3. Over the past 25 years, I have developed extensive experience with nuclear fuel cycle-related issues, including standards and strategies for radioactive waste storage and disposal, accountability with respect to measurement of radioactive effluent from nuclear facilities, health and environmental effects of nuclear testing, strategies for disposition of fissile materials, energy efficiency, and other energy-related issues. As reflected in my

curriculum vita, which is attached, I have authored or co-authored many publications on these subjects. I have testified before Congress on several occasions regarding issues related to nuclear waste, reprocessing, environmental releases of radioactivity, and regulation of nuclear weapons plants.

4. Between 1997 and 2002, I was on the expert team monitoring independent audits of the compliance of Los Alamos National Laboratory with the radiation release portion of the Clean Air Act (40 CFR 61 Subpart H), conducted under a Consent Decree, which was the result of a federal court finding that Los Alamos was out of compliance with Subpart H. In that capacity I have reviewed extensive records, models, facilities, procedures, measurements, and other aspects of the Los Alamos National Laboratory air emissions control and measurement program in order to determine whether the audits were being properly conducted and whether they were thoroughly done. I am the principal author of an assessment of the radioactive waste management and disposal costs of depleted uranium from the National Enrichment Facility (2004 and 2005) and of an analysis of U.S. waste classification regulations. I was the director of a team that analyzed ANDRA's plans for a geological repository for high level radioactive waste in France on behalf of a French government-sponsored stakeholder committee (2004). I have also served as a member of the Radiation Advisory Committee of the U.S. Environmental Protection Agency's (EPA's) Science Advisory Board from 1992 to 1994 and on the EPA's Advisory Subcommittee on Radiation Standards, which is part of the National Advisory Committee on Environmental Policy and Technology. In addition, I have served as a consultant to numerous organizations, as mentioned in my CV.

5. I have written a number of books and other publications analyzing the safety, economics, and efficiency of various energy sources, including nuclear power and sustainable energy sources such as wind and solar energy. I was the principal author of the first evaluation of energy end-uses and energy efficiency potential in the U.S. economy (published by the Electronics Research Laboratory, University of California at Berkeley in 1971). I was also the principal author of the first overview study on *Energy and Agriculture in the Third World* (Ballinger 1975). This study included consideration of both traditional and modern energy sources. I was one of the principal technical staff persons of the Ford Foundation Energy Policy Project, and a co-author of its final report, *A Time to Choose*, which helped shape U.S. energy policy during the mid-to-late 1970s. I am co-author of *Investment Planning in the Energy Sector*, which is an economic model published by the Lawrence Berkeley Laboratory in 1975. I am also the author of *Nuclear Power Deception* (Apex Books 1999), an analysis of the costs for nuclear power in the United States. On behalf of the SEED Coalition, I have assessed the capital costs of proposed nuclear power reactors in South Texas (2008). In addition, I am the author of *Carbon-Free and Nuclear Free* (RDR Books and IEER Press 2007, reprinted in 2008), the first analysis of a transition to a U.S. economy based completely on renewable energy, without any use of fossil fuels or nuclear power. I have been a consultant on energy issues to several U.N. agencies, the Tennessee Valley Authority (TVA), the Lower Colorado River Authority, the Lawrence Berkeley Laboratory, Edison Electric

Institute, and the Congressional Office on Technology Assessment. I was elected a Fellow of the American Physical Society in 2007, an honor granted to at most one-half of one percent of APS members.

6. I have also done extensive work with respect to the health and environmental effects of nuclear weapons production. I am the principal author of the first independent assessment of radioactivity emissions from a nuclear weapons plant (1989) and a co-author of the first audit of the cost of the U.S. nuclear weapons program (*Atomic Audit*, 1998). I am also a co-author of the first global assessment of the health and environmental effects of nuclear weapons production (*Nuclear Wastelands*, 1995 and 2000), which was nominated for a Pulitzer Prize by MIT Press and the principal editor of this book.

7. I have reviewed TVA's 2008 Final Supplemental Environmental Impact Statement for Watts Bar Unit 2 ("FSEIS") and the documents that it cites with respect to the need for power and alternative sources of energy, including TVA's 1972 Final Environmental Statement for construction of Watts Bar 1 and 2, the NRC's 1995 Final Environmental Statement for operation of Watts Bar 1 and 2, and TVA's Integrated Resource Plan (1995).

8. I am responsible for the factual content and expert opinions expressed in the attached report entitled "Watts Bar Unit 2: Analysis of Need and Alternatives." The facts presented in my report are true and correct to the best of my knowledge, and the opinions expressed therein are based on my best professional judgment.



Dr. Arjun Makhijani

July 11, 2009

Curriculum Vita of Arjun Makhijani

Address and Phone:

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Takoma Park, MD 20912
Phone: 301-270-5500
e-mail: arjun@ieer.org
Website: www.ieer.org

A recognized authority on energy issues, Dr. Makhijani is the author and co-author of numerous reports and books on energy and environment related issues, including two published by MIT Press. He was the principal author of the first study of the energy efficiency potential of the US economy published in 1971. He is the author of *Carbon-Free and Nuclear-Free: A Roadmap for U.S. Energy Policy* (2007).

In 2007, he was elected Fellow of the American Physical Society. He was named a Ploughshares Hero, by the Ploughshares Fund (2006); was awarded the Jane Bagley Lehman Award of the Tides Foundation in 2008 and the Josephine Butler Nuclear Free Future Award in 2001; and in 1989 he received The John Bartlow Martin Award for Public Interest Magazine Journalism of the Medill School of Journalism, Northwestern University, with Robert Alvarez. He has many published articles in journals and magazines as varied as *The Bulletin of the Atomic Scientists*, *Environment*, *The Physics of Fluids*, *The Journal of the American Medical Association*, and *The Progressive*, as well as in newspapers, including the *Washington Post*.

Dr. Makhijani has testified before Congress, and has appeared on ABC World News Tonight, the CBS Evening News, CBS 60 Minutes, NPR, CNN, and BBC, among others. He has served as a consultant on energy issues to utilities, including the Tennessee Valley Authority, the Edison Electric Institute, the Lawrence Berkeley Laboratory, and several agencies of the United Nations.

Education:

- Ph.D. University of California, Berkeley, 1972, from the Department of Electrical Engineering. Area of specialization: plasma physics as applied to controlled nuclear fusion. Dissertation topic: multiple mirror confinement of plasmas. Minor fields of doctoral study: statistics and physics.
- M.S. (Electrical Engineering) Washington State University, Pullman, Washington, 1967. Thesis topic: electromagnetic wave propagation in the ionosphere.
- Bachelor of Engineering (Electrical), University of Bombay, Bombay, India, 1965.

Current Employment:

- 1987-present: President and Senior Engineer, Institute for Energy and Environmental Research, Takoma Park, Maryland. (part-time in 1987).
- February 3, 2004-present, Associate, SC&A, Inc., one of the principal investigators in the audit of the reconstruction of worker radiation doses under the Energy Employees Occupational Illness Compensation Program Act under contract to the Centers for Disease Control and Prevention, U.S. Department of Health and Human Services.

Other Long-term Employment

- 1984-88: Associate Professor, Capitol College, Laurel, Maryland (part-time in 1988).
- 1983-84: Assistant Professor, Capitol College, Laurel, Maryland.
- 1977-79: Visiting Professor, National Institute of Bank Management, Bombay, India. Principal responsibility: evaluation of the Institute's extensive pilot rural development program.
- 1975-87: Independent consultant (see page 2 for details)
- 1972-74: Project Specialist, Ford Foundation Energy Policy Project. Responsibilities included research and writing on the technical and economic aspects of energy conservation and supply in the U.S.; analysis of Third World rural energy problems; preparation of requests for proposals; evaluation of proposals; and the management of grants made by the Project to other institutions.
- 1969-70: Assistant Electrical Engineer, Kaiser Engineers, Oakland California. Responsibilities included the design and checking of the electrical aspects of mineral industries such as cement plants, and plants for processing mineral ores such as lead and uranium ores. Pioneered the use of the desk-top computer at Kaiser Engineers for performing electrical design calculations.

Professional Societies:

- Institute of Electrical and Electronics Engineers and its Power Engineering Society
- American Physical Society (Fellow)
- Health Physics Society
- American Association for the Advancement of Science

Awards and Honors:

- The John Bartlow Martin Award for Public Interest Magazine Journalism of the Medill School of Journalism, Northwestern University, 1989, with Robert Alvarez
- The Josephine Butler Nuclear Free Future Award, 2001
- Ploughshares Hero, Ploughshares Fund, 2006
- Elected a Fellow of the American Physical Society, 2007, "*For his tireless efforts to provide the public with accurate and understandable information on energy and environmental issues*"
- Jane Bagley Lehman Award of the Tides Foundation, 2007/2008

Invited Faculty Member, Center for Health and the Global Environment, Harvard Medical School: Annual Congressional Course, *Environmental Change: The Science and Human Health Impacts*, April 18-19, 2006, Lecture Topic: An Update on Nuclear Power - Is it Safe?

Consulting Experience, 1975-1987

Consultant on a wide variety of issues relating to technical and economic analyses of alternative energy sources; electric utility rates and investment planning; energy conservation; analysis of energy use in agriculture; US energy policy; energy policy for the Third World; evaluations of portions of the nuclear fuel cycle.

Partial list of institutions to which I was a consultant in the 1975-87 period:

- Tennessee Valley Authority
- Lower Colorado River Authority
- Federation of Rocky Mountain States
- Environmental Policy Institute
- Lawrence Berkeley Laboratory
- Food and Agriculture Organization of the United Nations
- International Labour Office of the United Nations
- United Nations Environment Programme
- United Nations Center on Transnational Corporations
- The Ford Foundation
- Economic and Social Commission for Asia and the Pacific
- United Nations Development Programme

Languages: English, French, Hindi, Sindhi, and Marathi.

Reports, Books, and Articles (Partial list)

(Newsletter, newspaper articles, excerpts from publications reprinted in books and magazines or adapted therein, and other similar publications are not listed below)

Hower, G.L., and A. Makhijani, "Further Comparison of Spread-F and Backscatter Sounder Measurements," *Journal of Geophysical Research*, 74, p. 3723, 1969.

Makhijani, A., and A.J. Lichtenberg, *An Assessment of Energy and Materials Utilization in the U.S.A.*, University of California Electronics Research Laboratory, Berkeley, 1971.

Logan, B. G., A.J. Lichtenberg, M. Lieberman, and A. Makhijani, "Multiple-Mirror Confinement of Plasmas," *Physical Review Letters*, 28, 144, 1972.

Makhijani, A., and A.J. Lichtenberg, "Energy and Well-Being," *Environment*, 14, 10, June 1972.

Makhijani, A., A.J. Lichtenberg, M. Lieberman, and B. Logan, "Plasma Confinement in Multiple Mirror Systems. I. Theory," *Physics of Fluids*, 17, 1291, 1974.

A Time to Choose: America's Energy Future, final report of the Ford Foundation Energy Policy Project, Ballinger, Cambridge, 1974. One of many co-authors.

Makhijani, A., and A. Poole, *Energy and Agriculture in the Third World*, Ballinger, Cambridge, 1975.

Makhijani, A., *Energy Policy for the Rural Third World*, International Institute for Environment and Development, London, 1976.

Kahn, E., M. Davidson, A. Makhijani, P. Caesar, and S. Berman, *Investment Planning in the Energy Sector*, Lawrence Berkeley Laboratory, Berkeley, 1976.

Makhijani, A., "Solar Energy for the Rural Third World," *Bulletin of the Atomic Scientists*, May 1977.

Makhijani, A., "Energy Policy for Rural India," *Economic and Political Weekly*, 12, Bombay, 1977.

Makhijani, A., *Some Questions of Method in the Tennessee Valley Authority Rate Study*, Report to the Tennessee Valley Authority, Chattanooga, 1978.

Makhijani, A., *The Economics and Sociology of Alternative Energy Sources*, Economic and Social Commission for Asia and the Pacific, 1979.

Makhijani, A., *Energy Use in the Post-Harvest Component of the Food Systems in Ivory Coast and Nicaragua*, Food and Agriculture Organization of the United Nations, Rome, 1982.

Makhijani, A., *Oil Prices and the Crises of Debt and Unemployment: Methodological and Structural Aspects*, International Labour Office of the United Nations, Final Draft Report, Geneva, April 1983.

Makhijani, A., and D. Albright, *The Irradiation of Personnel at Operation Crossroads*, International Radiation Research and Training Institute, Washington, D.C., 1983.

Makhijani, A., K.M. Tucker, with Appendix by D. White, *Heat, High Water, and Rock Instability at Hanford*, Health and Energy Institute, Washington, D.C., 1985.

Makhijani, A., and J. Kelly, *Target: Japan - The Decision to Bomb Hiroshima and Nagasaki*, July 1985, a report published as a book in Japanese under the title, *Why Japan?*, Kyoikusha, Tokyo, 1985.

Makhijani, A., *Experimental Irradiation of Air Force Personnel During Operation Redwing - 1956*, Environmental Policy Institute, Washington, D.C., 1985.

Makhijani, A., and R.S. Browne, "Restructuring the International Monetary System," *World Policy Journal*, New York, Winter, 1985-86.

Makhijani, A., R. Alvarez, and B. Blackwelder, *Deadly Crop in the Tank Farm: An Assessment of Management of High-Level Radioactive Wastes in the Savannah River Plant Tank Farm*, Environmental Policy Institute, Washington, D.C., 1986.

Makhijani, A., "Relative Wages and Productivity in International Competition," *College Industry Conference Proceedings*, American Society for Engineering Education, Washington, D.C., 1987.

Makhijani, A., *An Assessment of the Energy Recovery Aspect of the Proposed Mass Burn Facility at Preston, Connecticut*, Institute for Energy and Environmental Research, Takoma Park, 1987.

Makhijani, A., R. Alvarez, and B. Blackwelder, *Evading the Deadly Issues: Corporate Mismanagement of America's Nuclear Weapons Production*, Environmental Policy Institute, Washington, D.C., 1987.

Franke, B. and A. Makhijani, *Avoidable Death: A Review of the Selection and Characterization of a Radioactive Waste Repository in West Germany*, Health & Energy Institute, Washington, DC; Institute for Energy and Environmental Research, Takoma Park, November 1987.

Makhijani, A., *Release Estimates of Radioactive and Non-Radioactive Materials to the Environment by the Feed Materials Production Center, 1951-85*, Institute for Energy and Environmental Research, Takoma Park, 1988.

Alvarez, R., and A. Makhijani, "The Hidden Nuclear Legacy," *Technology Review*, 91, 42, 1988.

Makhijani, A., Annie Makhijani, and A. Bickel, *Saving Our Skins: Technical Potential and Policies for the Elimination of Ozone-Depleting Chlorine Compounds*, Environmental Policy Institute and Institute for Energy and Environmental Research, Takoma Park, 1988.

Makhijani, A., Annie Makhijani, and A. Bickel, *Reducing Ozone-Depleting Chlorine and Bromine Accumulations in the Stratosphere: A Critique of the U.S. Environmental Protection Agency's Analysis and Recommendations*, Institute for Energy and Environmental Research and Environmental Policy Institute/Friends of the Earth, Takoma Park, 1989.

Makhijani, A., and B. Franke, *Addendum to Release Estimates of Radioactive and Non-Radioactive Materials to the Environment by the Feed Materials Production Center, 1951-85*, Institute for Energy and Environmental Research, Takoma Park, 1989.

Makhijani, A., *Global Warming and Ozone Depletion: An Action Program for States*, Institute for Energy and Environmental Research, Takoma Park, 1989.

Makhijani, A., *Managing Municipal Solid Wastes in Montgomery County*, Prepared for the Sugarloaf Citizens Association, Institute for Energy and Environmental Research, Takoma Park, 1990.

Saleska, S., and A. Makhijani, *To Reprocess or Not to Reprocess: The Purex Question - A Preliminary Assessment of Alternatives for the Management of N-Reactor Irradiated Fuel at the*

U.S. Department of Energy's Hanford Nuclear Weapons Production Facility, Institute for Energy and Environmental Research, Takoma Park, 1990.

Makhijani, A., "Common Security is Far Off," *Bulletin of the Atomic Scientists*, May 1990.

Makhijani, A., *Draft Power in South Asian Agriculture: Analysis of the Problem and Suggestions for Policy*, prepared for the Office of Technology Assessment, Institute for Energy and Environmental Research, Takoma Park, 1990.

Mehta, P.S., S.J. Mehta, A.S. Mehta, and A. Makhijani, "Bhopal Tragedy's Health Effects: A Review of Methyl Isocyanate Toxicity," *JAMA* 264, 2781, December 1990.

Special Commission of International Physicians for the Prevention of Nuclear War and the Institute for Energy and Environmental Research, *Radioactive Heaven and Earth: The Health and Environmental Effects of Nuclear Weapons Testing In, On, and Above the Earth*, Apex Press, New York, 1991. One of many co-authors.

Makhijani, A., and S. Saleska, *High Level Dollars Low-Level Sense: A Critique of Present Policy for the Management of Long-Lived Radioactive Waste and Discussion of an Alternative Approach*, Apex Press, New York, 1992.

Makhijani, A., *From Global Capitalism to Economic Justice: An Inquiry into the Elimination of Systemic Poverty, Violence and Environmental Destruction in the World Economy*, Apex Press, New York, 1992.

Special Commission of International Physicians for the Prevention of Nuclear War and the Institute for Energy and Environmental Research, *Plutonium: Deadly Gold of the Nuclear Age*, International Physicians Press, Cambridge, MA, 1992. One of several co-authors.

Makhijani, A., "Energy Enters Guilty Plea," *Bulletin of the Atomic Scientists*, March/April 1994.

Makhijani, A., "Open the Files," *Bulletin of the Atomic Scientists*, Jan./Feb. 1995.

Makhijani, A., "'Always' the Target?" *Bulletin of the Atomic Scientists*, May/June 1995.

Makhijani, A., and Annie Makhijani, *Fissile Materials in a Glass, Darkly: Technical and Policy Aspects of the Disposition of Plutonium and Highly Enriched Uranium*, IEER Press, Takoma Park, 1995.

Makhijani, A., and K. Gurney, *Mending the Ozone Hole: Science, Technology, and Policy*, MIT Press, Cambridge, MA, 1995.

Makhijani, A., H. Hu, K. Yih, eds., *Nuclear Wastelands: A Global Guide to Nuclear Weapons Production and the Health and Environmental Effects*, MIT Press, Cambridge, MA, 1995.

Zerriffi, H., and A. Makhijani, *The Nuclear Safety Smokescreen: Warhead Safety and Reliability and the Science Based Stockpile Stewardship Program*, Institute for Energy and Environmental Research, Takoma Park, May 1996.

Zerriffi, H., and A. Makhijani, "The Stewardship Smokescreen," *Bulletin of the Atomic Scientists*, September/October 1996.

Makhijani, A., *Energy Efficiency Investments as a Source of Foreign Exchange*, prepared for the International Energy Agency Conference in Chelyabinsk, Russia, 24-26 September 1996.

Makhijani, A., "India's Options," *Bulletin of the Atomic Scientists*, March/April 1997.

Ortmeyer, P. and A. Makhijani, "Worse than We Knew," *Bulletin of the Atomic Scientists*, November/December 1997.

Fioravanti, M., and A. Makhijani, *Containing the Cold War Mess: Restructuring the Environmental Management of the U.S. Nuclear Weapons Complex*, Institute for Energy and Environmental Research, Takoma Park, October 1997.

Principal author of three chapters in Schwartz, S., ed., *Atomic Audit: The Costs and Consequences of U.S. Nuclear Weapons Since 1940*, Brookings Institution, Washington, D.C., 1998.

Franke, B., and A. Makhijani, *Radiation Exposures in the Vicinity of the Uranium Facility in Apollo, Pennsylvania*, Institute for Energy and Environmental Research, Takoma Park, February 2, 1998.

Fioravanti, M., and A. Makhijani, *Supplement to Containing the Cold War Mess - IEER's Response to the Department of Energy's Review*, Institute for Energy and Environmental Research, Takoma Park, March 1998.

Makhijani, A., "A Legacy Lost," *Bulletin of the Atomic Scientists*, July/August 1998.

Makhijani, A., and Hisham Zerriffi, *Dangerous Thermonuclear Quest: The Potential of Explosive Fusion Research for the Development of Pure Fusion Weapons*, Institute for Energy and Environmental Research, Takoma Park, July 1998.

Makhijani, A., and Scott Saleska, *The Nuclear Power Deception - U.S. Nuclear Mythology from Electricity "Too Cheap to Meter" to "Inherently Safe" Reactors*, Apex Press, New York, 1999.

Makhijani, A., "Stepping Back from the Nuclear Cliff," *The Progressive*, vol. 63, no. 8, August 1999.

Makhijani, A., Bernd Franke, and Hisham Zerriffi, *Preliminary Partial Dose Estimates from the Processing of Nuclear Materials at Three Plants during the 1940s and 1950s*, Institute for Energy and Environmental Research, Takoma Park, September 2000. (Prepared under contract to the newspaper USA Today.)

Makhijani, A., and Bernd Franke, *Final Report of the Institute for Energy and Environmental Research on the Second Clean Air Act Audit of Los Alamos National Laboratory by the Independent Technical Audit Team*, Institute for Energy and Environmental Research, Takoma Park, December 13, 2000.

Makhijani, A., *Plutonium End Game: Managing Global Stocks of Separated Weapons-Usable Commercial and Surplus Nuclear Weapons Plutonium*, Institute for Energy and Environmental Research, Takoma Park, January 2001.

Makhijani, A., Hisham Zerriffi, and Annie Makhijani, "Magical Thinking: Another Go at Transmutation," *Bulletin of the Atomic Scientists*, March/April 2001.

Makhijani, A., *Ecology and Genetics: An Essay on the Nature of Life and the Problem of Genetic Engineering*. New York: Apex Press, 2001.

Makhijani, A., "Burden of Proof," *Bulletin of the Atomic Scientists*, July/August 2001.

Makhijani, A., "Reflections on September 11, 2001," in Kamla Bhasin, Smitu Kothari, and Bindia Thapar, eds., *Voices of Sanity: Reaching Out for Peace*, Lokayan, New Delhi, 2001, pp. 59-64.

Makhijani, A., and Michele Boyd, *Poison in the Vadose Zone: An examination of the threats to the Snake River Plain aquifer from the Idaho National Engineering and Environmental Laboratory*, Institute for Energy and Environmental Research, Takoma Park, October 2001.

Makhijani, A., *Securing the Energy Future of the United States: Securing the Energy Future of the United States: Oil, Nuclear, and Electricity Vulnerabilities and a post-September 11, 2001 Roadmap for Action*, Institute for Energy and Environmental Research, Takoma Park, November 2001.

Makhijani, A., and Sriram Gopal, *Setting Cleanup Standards to Protect Future Generations: The Scientific Basis of Subsistence Farmer Scenario and Its Application to the Estimation of Radionuclide Soil Action Levels (RSALs) for Rocky Flats*, Institute for Energy and Environmental Research, Takoma Park, December 2001.

Makhijani, A., "Some Factors in Assessing the Response to September 11, 2001," *Medicine and Global Survival*, International Physicians for the Prevention of Nuclear War, Cambridge, Mass., February 2002.

Makhijani, Annie, Linda Gunter, and A. Makhijani, *Cogema: Above the Law?: Concerns about the French Parent Company of a U.S. Corporation Set to Process Plutonium in South Carolina*. A report prepared by Institute for Energy and Environmental Research and Safe Energy Communication Council. Takoma Park, MD, May 7, 2002.

Deller, N., A. Makhijani, and J. Burroughs, eds., *Rule of Power or Rule of Law? An Assessment of U.S. Policies and Actions Regarding Security-Related Treaties*, Apex Press, New York, 2003.

Makhijani, A., "Nuclear targeting: The first 60 years," *Bulletin of the Atomic Scientists*, May/June 2003.

Makhijani, A., "Strontium," *Chemical & Engineering News*, September 8, 2003.

Makhijani, A., and Nicole Deller, *NATO and Nuclear Disarmament: An Analysis of the Obligations of the NATO Allies of the United States under the Nuclear Non-Proliferation Treaty and the Comprehensive Test Ban Treaty*, Institute for Energy and Environmental Research, Takoma Park, Maryland, October 2003.

Makhijani, A., *Manifesto for Global Democracy: Two Essays on Imperialism and the Struggle for Freedom*, Apex Press, New York, 2004.

Makhijani, A., "Atomic Myths, Radioactive Realities: Why nuclear power is a poor way to meet energy needs," *Journal of Land, Resources, & Environmental Law*, v. 24, no. 1, 2004, pp. 61-72. Adapted from an oral presentation given on April 18, 2003, at the Eighth Annual Wallace Stegner Center Symposium titled "Nuclear West: Legacy and Future," held at the University of Utah S.J. Quinney College of Law."

Makhijani, A., and Michele Boyd, *Nuclear Dumps by the Riverside: Threats to the Savannah River from Radioactive Contamination at the Savannah River Site*, Institute for Energy and Environmental Research, Takoma Park, Maryland, March 2004.

Makhijani, A., and Brice Smith, *The Role of E.I. du Pont de Nemours and Company (Du Pont) and the General Electric Company in Plutonium Production and the Associated I-131 Emissions from the Hanford Works*, Institute for Energy and Environmental Research, Takoma Park, Maryland, March 30, 2004.

Makhijani, A., Peter Bickel, Aiyu Chen, and Brice Smith, *Cash Crop on the Wind Farm: A New Mexico Case Study of the Cost, Price, and Value of Wind-Generated Electricity*, Institute for Energy and Environmental Research, Takoma Park, Maryland, April 2004.

Makhijani, A., Lois Chalmers, and Brice Smith, *Uranium Enrichment: Just Plain Facts to Fuel an Informed Debate on Nuclear Proliferation and Nuclear Power*, Institute for Energy and Environmental Research, Takoma Park, Maryland, October 15, 2004.

Makhijani, A., and Brice Smith, *Costs and Risks of Management and Disposal of Depleted Uranium from the National Enrichment Facility Proposed to be Built in Lea County New Mexico by LES*, Institute for Energy and Environmental Research, Takoma Park, Maryland, November 24, 2004.

Makhijani, A., project director, *Examen critique du programme de recherche de l'ANDRA pour déterminer l'aptitude du site de Bure au confinement géologique des déchets à haute activité et à vie longue: Rapport final*, prepared for le Comité ocal d'Information et de Suivi; coordinator: Annie Makhijani; authors: Detlef Appel, Jaak Daemen, George Danko, Yuri Dublyansky, Rod Ewing, Gerhard Jentzsch, Horst Letz, Arjun Makhijani, Institute for Energy and Environmental Research, Takoma Park, Maryland, December 2004

Institute for Energy and Environmental Research, *Lower Bound for Cesium-137 Releases from the Sodium Burn Pit at the Santa Susana Field Laboratory*, IEER, Takoma Park, Maryland, January 13, 2005. (Authored by A. Makhijani and Brice Smith.)

Institute for Energy and Environmental Research, *Iodine-131 Releases from the July 1959 Accident at the Atomics International Sodium Reactor Experiment*, IEER, Takoma Park, Maryland, January 13, 2005. (Authored by A. Makhijani and Brice Smith.)

Makhijani, A., and Brice Smith. *Update to Costs and Risks of Management and Disposal of Depleted Uranium from the National Enrichment Facility Proposed to be Built in Lea County New Mexico by LES*. Institute for Energy and Environmental Research, Takoma Park, Maryland, July 5, 2005.

Makhijani, A., "A Readiness to Harm: The Health Effects of Nuclear Weapons Complexes," *Arms Control Today*, **35**, July/August 2005.

Makhijani, A., *Bad to the Bone: Analysis of the Federal Maximum Contaminant Levels for Plutonium-239 and Other Alpha-Emitting Transuranic Radionuclides in Drinking Water*, Institute for Energy and Environmental Research, Takoma Park, Maryland, August 2005.

Makhijani, A., and Brice Smith, *Dangerous Discrepancies: Missing Weapons Plutonium in Los Alamos National Laboratory Waste Accounts*, Institute for Energy and Environmental Research, Takoma Park, Maryland, April 21, 2006.

Makhijani, Annie, and A. Makhijani, *Low-Carbon Diet without Nukes in France: An Energy Technology and Policy Case Study on Simultaneous Reduction of Climate Change and Proliferation Risks*, Institute for Energy and Environmental Research, Takoma Park, Maryland, May 4, 2006.

Makhijani, Annie, and A. Makhijani. *Shifting Radioactivity Risks: A Case Study of the K-65 Silos and Silo 3 Remediation and Waste Management at the Fernald Nuclear Weapons Site*, Institute for Energy and Environmental Research, Takoma Park, Maryland, August 2006.

Smith, Brice, and A. Makhijani, "Nuclear is Not the Way," *Wilson Quarterly*, v.30, p. 64, Autumn 2006.

Makhijani, A., Brice Smith, and Michael C. Thorne, *Science for the Vulnerable: Setting Radiation and Multiple Exposure Environmental Health Standards to Protect Those Most at Risk*, Institute for Energy and Environmental Research, Takoma Park, Maryland, October 19, 2006.

Makhijani, A., *Carbon-Free and Nuclear Free: A Roadmap for U.S. Energy Policy*, IEER Press, Takoma Park, Maryland; RDR Books, Muskegon, Michigan, 2007.

Makhijani, A., *Assessing Nuclear Plant Capital Costs for the Two Proposed NRG Reactors at the South Texas Project Site*, Institute for Energy and Environmental Research, Takoma Park, Maryland, March 24, 2008.

Makhijani, A., *Energy Efficiency Potential: San Antonio's Bright Energy Future*, Institute for Energy and Environmental Research, Takoma Park, Maryland, October 9, 2008.

Makhijani, A., *The Use of Reference Man in Radiation Protection Standards and Guidance with Recommendations for Change*, Institute for Energy and Environmental Research, Takoma Park, Maryland, December 2008.

Makhijani, A., *Technical and Economic Feasibility of a Carbon-Free and Nuclear-Free Energy System in the United States*, Institute for Energy and Environmental Research, Takoma Park, Maryland, March 4, 2009.

Fundación Ideas para el Progreso, *A New Energy Model For Spain: Recommendations for a Sustainable Future* (originally: *Un nuevo modelo energético para España: Recomendaciones para un futuro sostenible*), by the Working Group of Foundation Ideas for Progress on Energy and Climate Change, Fundación Ideas , Madrid, May 20, 2009. Arjun Makhijani contributed Section 2.2. The cost of nuclear energy and the problem of waste.

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Watts Bar Unit 2: Analysis of Need and Alternatives

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July 11, 2007

Introduction

In the Tennessee Valley Authority's (TVA's) 2007 Watts Bar Unit 2 Final Supplemental Environmental Impact Statement (hereafter Watts Bar FSEIS), consideration of the need for the plant and alternatives to the plant is fundamentally incomplete and largely obsolete with respect to the consideration of costs, environmental impacts, relative merit of alternatives, and the state of the technological alternatives. TVA's analysis is based on outdated documents, including its 1972 Environmental Statement (ES) for construction of the plant and a 1995 Integrated Resource Plan and Environmental Impact Statement (IRP/EIS, hereafter referred to as the 1995 IRP).¹ In any event, the 1995 IRP does not support the proposed operation of Watts Bar Unit 2. In fact, the IRP considered and rejected that option, omitting it from the portfolio of options that TVA intended to pursue in the 25 years following issuance of the IRP.²

The analysis of the need for power and alternatives in the FSEIS is also incomplete and sketchy at best. It does not contain essential elements of a reasonable analysis of energy demand and alternative energy supplies, such as the potential for efficiency and renewables to meet the forecasted requirements, or the effects of climate legislation. The FSEIS contains no analysis of the effect of the economic crisis in the TVA region and the country as a whole. Further, the Watts Bar FSEIS does not take into account TVA's own statement that a new IRP is needed.

The TVA initiated a new IRP/EIS process for its electricity options in June 2009. The TVA should re-do the Watts Bar FSEIS after it has completed its proposed new IRP because no valid evaluation of the need for the project or a valid comparison with reasonable alternatives can be done until the new IRP/EIS process is complete.

¹ TVA 1972 and Energy Vision 2020 1995

² Federal Register 1996 p. 7572. The Record of Decision for the 1995 IRP was published in the Federal Register in 1996. The 1995 Final Environmental Statement deferred discussion of need to the 1995 IRP. (NRC 1995, p. 9-3)

A. Analysis in the Watts Bar FSEIS

The FSEIS provides a very cursory, business-as-usual approach to forecasting electricity demand. It takes a very short term view – projecting only to about 2015,³ for a project that would have a licensed lifetime of 40 years, takes no account of cost escalations that have plagued TVA nuclear projects in the past, and takes no account of the severe economic crisis in its projections or its analysis. Its core premise for electricity demand is stated as follows:

The primary factor affecting the demand for power in the TVA power service area (Region) is economic growth. Historically, regional economic growth has been more dependent on manufacturing than the U.S. average. This trend is forecast to continue as the Region benefits from its favorable location at the center of the auto industry in the southern U.S., even though job growth in the manufacturing sector is declining in the Region. Population growth is expected to be strong. Most migration to the Region is still due to job opportunities.⁴

In projecting continued population growth and increasing job opportunities, which would both tend to contribute to economic growth and the need for electricity services (whether through supply or efficiency), the FSEIS takes no account of changes in the economic picture since 2007, including the devastating changes in the auto industry. Unemployment in Tennessee, for instance, increased from a low of 4.5 percent in April 2007 to 10.7 percent in May 2009.⁵ Nor does TVA note that unemployment in Alabama increased from a rate of 3.3 percent in January 2007 to 9.8 percent in May 2009.⁶ These realities are reflected in declining TVA power sales, as noted in a TVA press release describing its filing by the TVA with the Securities and Exchange Commission:

Power sales during the second quarter of 2009 decreased by 9.4 percent from sales for the second quarter last year, and power sales for the first six months of fiscal year 2009 were 5.6 percent below sales for the first six months of fiscal year 2008 according to TVA's quarterly financial report filed with the Securities and Exchange Commission today.⁷

These are huge declines. Moreover, Fiscal Year 2008 sales were 180,000 GWh, only about half a percent more than FY 2007.⁸ This would make FY 2007 sales about 179,000 GWh. Current trends (5.6 percent below 2008 levels for the first half of the fiscal year) would put TVA sales at about 170,000 GWh for FY 2009, even if one ignores the deteriorating trend within the first half of the fiscal year that is evident from the data in the quote above. Hence, at present, TVA electricity sales are set to be well below the lowest forecast in the FSEIS, which is for a flat sales projection. The current outlook is for FY 2009 sales to be back to the 2004 or 2005 level and perhaps lower.⁹ It is unclear how long recovery of demand to above the recent 2008 peak might

³ Watts Bar FSEIS 2007 Figure 1-3 (p. 13)

⁴ Watts Bar FSEIS 2007 p. 12

⁵ BLS 2009 TN (preliminary number for May 2009)

⁶ BLS 2009 AL (preliminary number for May 2009)

⁷ TVA 2009

⁸ TVA 2008

⁹ Some data in this paragraph are taken from TVA's FY 2008 SEC filing (TVA SEC 2008)

take, given economic uncertainties, potential changes in efficiency regulations, and climate-related regulation and legislation. TVA has acknowledged as much since its own prognosis for 2009, and possibly 2010 or longer, is grim. According to its most recent quarterly report with the SEC:

Financial Outlook

For the remainder of 2009 and perhaps beyond, TVA is facing several financial pressures, including the following:

Rates and Electricity Sales. On April 1, 2009, TVA reduced its FCA [Fuel Cost Adjustment] for the second time this year. Combined with a previous six percent drop on January 1, 2009, this latest seven percent decrease rolls back much of the 17 percent increase in the FCA from October 2008. The FCA is applied to the bills of the majority of TVA's customers to compensate for TVA's costs associated with fuel, purchased power, and emissions allowances. The two decreases are due to lower than forecasted fuel and purchased power costs.

The effects of the economic downturn are resulting in less demand for electric power. Sales of electricity are about six percent below 2008 levels and could decline further if commercial and industrial employers continue to reduce production in response to the downturn. Through March 2009, directly served industrial sales are down approximately 14.9 percent, while municipal and cooperative sales have experienced a 3.1 percent decline compared to the prior year.¹⁰

In sum, the business-as-usual forecast (low, medium, high) in the Watts Bar FSEIS is completely inappropriate in the present economic circumstances and their effect on demand. While the failure to include these circumstances is understandable, in that the FSEIS was completed in June 2007, it does not negate the fact that its economic basis is obsolete and cannot be used to establish the need for the project. Basing the need for the project by 2013 on the FSEIS analysis would risk the same type of problem that the TVA encountered in the mid-to-late 1970s when its power projections turned out to be too high (see below) and it cancelled or postponed several nuclear power plants. The FSEIS analysis is so obsolete that it stands in stark contrast to TVA sales in the past year, current trends, and TVA's own analysis of its outlook as reported to the Securities and Exchange Commission.

The FSEIS appeals to a higher capacity factor of 90 percent in attempting to justify the completion of Watts Bar Unit 2. However, the in light of the severe and ongoing decline in demand, the higher capacity factor is irrelevant -- it will result in even more generation potential in a period of declining demand, with the course and timing of the economic recovery very uncertain. In this context of declining demand, it is also unclear whether expenditures on new capacity will result in lower costs as the TVA claims; the FSEIS analysis (Section 1.6) is in the context of constant or rising demand. Further, the TVA has not provided any comparison of potential lowering of costs if the same money were invested in other resources, notably efficiency and demand response, an area of stated TVA priority (see below). The FSEIS has also

¹⁰ TVA SEC 2009 p. 45, emphasis added.

not provided an assessment of the relative risks of nuclear versus efficiency improvements. The same is true of emissions. The FSEIS has not analyzed whether emissions will be lowered more if efficiency is improved, given the same expenditures as would be expended on Watts Bar completion.¹¹

A related problem is that the Watts Bar FSEIS takes no account of the history of delays and cost escalations that have plagued nuclear projects. This is not just a general problem, but rather specific to TVA. In fact, Watts Bar Unit 1 took 23 years to complete.¹² The implications of delay of even a few years on the plant's economics and on the attractiveness of shorter lead time alternatives are not discussed. Indeed, there is no analysis of efficiency at all, even though TVA has stated that this is a priority and that TVA wants to be a leader in efficiency and demand response.¹³ The FSEIS contains only a single conclusory statement about needing more generating capacity without any analysis of the capacity potential of efficiency and demand response:

The amount of generating capacity, the source for which is yet to be determined (TBD), increases between 2008 and 2013. During this period, the need for capacity of any type (baseload, intermediate or peaking) increases by 3800 MWs in that five year period; Completing WBN Unit 2 with its 1150 MWs would only meet part of this projected need. The TVA Board recently announced in the form of a strategic plan that TVA would place greater emphasis on increasing energy efficiency and energy conservation and more use of renewable energy resources to help meet and reduce future demand. These actions would help address the projected shortfall that remains even if WBN Unit 2 is completed.¹⁴

B. Failure to Consider Energy Efficiency and Alternative Energy Sources

Chapter 2 of the FSEIS is supposed to be about "Alternatives and the Proposed Action." However, in essence it is only about the proposed action, since Chapter 1 does not consider alternatives (see the quote above) and neither does Chapter 2:

The need for power analysis presented in Chapter 1 shows how completion of WBN Unit 2 would help TVA meet expected demands for increased baseload power and the need for greater operating reserves. WBN Unit 2 completion would also provide more flexibility to reduce fossil plant emissions and lower the cost of power. To meet the need for additional baseload power and the objective of maximizing the use of exiting [sic] assets, TVA is proposing to follow through with its original plans to complete WBN Unit 2.¹⁵

¹¹ See Watts Bar FSEIS 2007, p. 19 for TVA's assertions regarding capacity factor, cost, and emissions as grounds for completion of Watts Bar 2.

¹² Construction started in 1973 and start up was in 1996. See the TVA Watts Bar Web site at http://www.tva.gov/sites/wattsbar_nuc.htm

¹³ See, for instance, TVA Staff Report 2009 p. 59.

¹⁴ Watts Bar FSEIS 2007 pp. 14-15

¹⁵ Watts Bar FSEIS 2007 p. 19

By any standard of reasonableness this discussion is surely inadequate to address the broad range of energy alternatives available to TVA. It is especially inadequate by the standard of TVA's 2007 strategic plan, which stressed efficiency as one of its top objectives:

In partnership with others, TVA will strive to be a leader in energy-efficiency improvements and peak demand reduction over the next five years. Improving energy efficiency and reducing peak demand are significant actions that help slow demand growth in a cost-effective manner while addressing air pollution and global climate change... Efficiency, conservation, and peak-shaving, along with on-site generation (such as photovoltaics), are key components of TVA's energy resource mix.¹⁶

Besides its own strategic plan, the TVA, like other utilities, is also required by the Energy Independence and Security Act of 2007 (EISA 2007) to consider incorporating a "smart grid" and increase energy efficiency. The TVA has begun the process of implementing the smart grid provisions of EISA 2007 in 2009.¹⁷ A smart grid is one in which there is communication between the consuming device (such as a clothes washing machine or a home air-conditioner) and the utility. Time of use electricity rates, the state of the system in terms of CO₂ emissions, and various other parameters can also be communicated, so that emissions can be minimized, customers can save money, and utilities can avoid the heavy expense of generating electricity during peak loads. Smart grids are also expected to play a significant role in the integration of renewable energy sources on a large scale into electricity supply systems.

On June 25, 2009, the TVA solicited public comment¹⁸ on its approach to the smart grid pursuant to EISA 2007, which is developed in a staff report.¹⁹ Overall, the staff report has accepted the recommendations set forth in the law for pursuing energy efficiency and smart grids (with the departures having largely to do with the fact that the TVA is a federally-owned and not an investor-owned utility). For instance, the staff report recommends adopting all the policies regarding efficiency promoting rate structures set forth in EISA 2007 as being "fully consistent" with TVA policy.

Besides making time of use rates and other information available to consumers that will allow efficiency improvements and changes in consumer behavior in unprecedented ways, a smart grid will also allow for much greater integration of distributed renewable energy resources into the grid.²⁰ Further, as described below, large changes in efficiency are on the horizon and are likely to be mandated by federal energy and climate legislations.

This energy and economic environment would make an up-to-date analysis of future electricity demand, and hence the need for the project, essential for any major investment, even outside of the economic downturn. For instance, the TVA needs to establish that the expected increase in demand of 3,800 MW cannot be met by conventional efficiency and demand response approaches alone. It has not done so. Combinations of demand response and efficiency can

¹⁶ TVA Strategic Plan 2007 p. 13

¹⁷ Federal Register 2009b

¹⁸ Federal Register 2009b

¹⁹ TVA Staff Report 2009

²⁰ See for instance, Xcel Energy's plans for a smart grid in the city of Boulder, Colorado. (Xcel Energy 2008)

meet demand growth as shown in, for instance, in an analysis of the Texas grid by the American Council for an Energy Efficient Economy (See Figure 1 at end of text).

.Note that over 90 percent of projected demand growth could be met by demand response and efficiency. In a parallel circumstance for TVA, Watts Bar would not be needed. Moreover, as noted above, the TVA Board has decided to emphasize efficiency, so that it should be incumbent upon TVA to make a thorough analysis showing that it could not do the job. The Watts Bar FSEIS has provided none.

In fact, the Watts Bar FSEIS does not provide a detailed analysis of any alternatives. Rather, the chapter on alternatives simply refers to other documents, including the 1972 Environmental Statement, which was written before the first energy crisis, and the 1995 IRP. The need for an analyses is not only essential for efficiency and demand response, but also for supply alternatives.

For instance, TVA's statement in the FSEIS that WBN Unit 2 is needed for baseload capacity also reflects the outdated view that only fossil fuel or nuclear plants can supply baseload. However, this is no longer the case. For instance, the National Renewable Energy Laboratory (NREL) has developed and published the system concept for dispatchable wind energy.²¹ The concept involves using wind power to supply electricity to the grid when the demand is there and to compress air for storage when there is excess wind energy supply. The stored air is heated using a small amount of natural gas and used to generate electricity in the same manner as normal large-scale compressed air storage facilities. The arrangement can be designed to supply dispatchable electricity at any desired load factor, with the appropriate matching of wind and storage capacity.

NREL's baseload wind energy concept, energy flows, wind generation, and grid supply are shown in Figures 2 through 5 (see at end of text), which are reproduced from the NREL publication already cited. The data presented in the figures show that it is possible at present to deploy a small amount of natural gas (about 400 to 1,200 Btu per kWh, depending on the capacity factor, as opposed to 7,000 Btu per kWh for a combined cycle power plant) to provide dispatchable wind. Emissions of CO₂ corresponding to these heat rates would be about 20 grams and 65 grams of CO₂ per kWh. Hence, such a power plant would reduce emissions relative to coal by 93 to 98 percent (which have emissions of almost 1,000 grams per kWh) and relative to natural gas by 85 to almost 95 percent depending on the mode in which it is deployed (baseload or intermediate load).²² All technologies employed in this baseload wind scheme have been deployed on a large scale. In fact, TVA considered large scale compressed air energy storage on almost the same scale as Watts Bar Unit 2 as part of its 1995 IRP.²³

Further, the wind energy industry has matured and become a major industry in the United States and elsewhere since the 1995 IRP and the 1996 ROD. For instance, the TVA considered 350 to

²¹ NREL 2006

²² Emission factors are from the EIA 2001 p. 140.

²³ Energy Vision 2020 1995 TD6, Options 1.2.2.1 and 1.2.2.2 (p. T6.2). The total capacity considered was 1,011 MW (3x337MW).

450 kW turbines at hub heights of 33 to 39 meters.²⁴ In 1996, the year that TVA published its ROD, only 1 MW of wind capacity was added and the total installed capacity was 1,703 MW.²⁵

By contrast, in 2008, the additions to wind capacity were 8,545 MW and the total installed capacity was over 25,000 MW.²⁶ The total investment in the economy was about \$17 billion in 2009, which yields an average cost of about \$2,000 per kW. Typical turbine size installed was 1,500 kW to 2,500 kW.²⁷ Offshore wind is becoming a major industry in several countries. Hub height has increased from the 33 to 39 meters assumed by TVA in 1995 to well over 100 meters. The E-126 wind turbine is rated at 6,000 KW (about 15 times the average size that TVA was considering) and has a hub height of 126 meters.²⁸ This has immense significance, because the economical resources at 100 meters are generally considerably greater than the resources at heights of 50 meters or less, or even at 70 meters in some cases. Figures 6 and 7 (see at end of text) show maps of wind resources in Indiana at 50 meters and at 100 meters. Note that at 50 meters, there is no large discernible area in Indiana with a capacity factor of more than 30 percent, whereas at 100 meters over half the state appears have capacity factors of 30 percent or more. Of course, capacity factor is directly related to wind power economics: The higher the capacity factor, the cheaper the power.

The Watts Bar FSEIS takes none of these changed realities into account.

Finally, the 1972 ES is completely obsolete in regard to need. It was prepared prior to the first energy crisis in the context of 7 percent annual electricity growth experienced until 1970. TVA projected that it needed the plant for the 1977-2012 period and that any delays beyond 1977 would have a heavy economic cost. Further, the TVA claimed that such delays would risk increasing loss of load probability to an “unacceptable” level.²⁹ TVA’s dire forecasts in its EIS were wrong – fortunately, given the serious delays that did occur. Watts Bar Unit 1 did not come on line till 1996 and Unit 2 obviously has not yet been completed. Indeed, the 1995 IRP itself acknowledged that the TVA’s projections in the 1970 to 1975 period were huge overestimates – see Figure 8 (at end of text), which is reproduced from the 1995 IRP.

The 1972 EIS is of no value in determining need. Moreover, even the 1995 IRP is obsolete in regard to alternatives.

C. Internal Contradictions Regarding Reliance on 1995 IRP

In the Summary of the FSEIS, TVA generally states that it relies for consideration of alternatives on the 1995 IRP, which is the most recent report that TVA has produced with regard to overall power planning and environmental impact:

²⁴ Energy Vision 2020 1995 TD6 p. T6.8

²⁵ Typical additions to capacity in early 1990s were tens of MW per year. (AWEA 2009 p. 4)

²⁶ AWEA 2009 p. 4

²⁷ AWEA 2009 p. 2 and Appendix

²⁸ The specifications can be found on the Wind Power *Wind Turbines and Wind Farms Database* at <http://www.thewindpower.net/wind-turbine-datasheet-223-enercon-e126-6000.php>

²⁹ TVA 1972, Section 1.2. The word in quotation marks is from page 1.2.9.

In the 1972 FES for Watts Bar Units 1 and 2, TVA considered a number of alternatives to constructing and operating WBN, including the No Action Alternative. TVA is proposing to complete WBN Unit 2 as originally designed except for modifications consistent with those made to Unit 1. Consistent with the Council on Environmental Quality's National Environmental Policy Act (NEPA) regulations [§1502.4(D)], this document also tiers off of *Energy Vision 2020 - An Integrated Resource Management Plan and Final Programmatic Environmental Impact Statement* (TVA 1995a), the *Final Environmental Impact Statement for the Production of Tritium in a Commercial Light Water Reactor* (DOE 1999), and the *Reservoir Operations Study Final Programmatic Environmental Impact Statement* (TVA 2004a) and incorporates by reference the balance of the environmental record pertinent to WBN. As such, this FSEIS identifies no new alternatives to those already addressed in those documents.³⁰

TVA's statement that it relies on the 1995 IRP is also consistent with a recent Federal Register notice regarding the proposed update of the IRP, in which TVA stated that it intends to use the 1995 IRP for its decisions until the process for developing a new IRP is complete:

In the mid-1990s, TVA developed an integrated resource plan with extensive public involvement. This process was completed with publication of the Energy Vision 2020 IRP/Final EIS in 1995 and the associated Record of Decision in 1996. Based on the extensive evaluation, TVA decided to adopt a flexible portfolio of supply- and demand-side energy resource options to meet the growing demand for electricity in the region and achieve the goals of the TVA Act and other congressional directives. This portfolio of energy resource options, as amended through subsequent EISs, will be a baseline for evaluations conducted as part of this EIS process. As appropriate, TVA expects to continue to implement the existing portfolio of resource options during this EIS process.³¹

But TVA glosses over the fact that, although the 1995 IRP considered the completion and operation of Watts Bar Unit 2,³² it was *not part of the preferred portfolio* selected by the TVA for implementation, which was described in the 1996 Record of Decision (ROD) as follows:

Portfolio options include: combustion turbines, the purchase of options for both base load and peaking power, improvements to the existing hydro system, purchases from independent power producers, combined cycle repowering of coal-fired plants, use of landfill and coalbed methane and refuse derived fuel, converting TVA's Bellefonte Nuclear Plant to an integrated combined cycle gasification plant with a chemical coproduct, one additional coal unit at TVA's Shawnee fossil plant, demand-side management programs, beneficial electrification programs, compressed air energy storage, wind turbines, a coal refinery, a biomass energy facility, and cascaded humidified advanced turbines. As events unfold, TVA can decide which of the portfolio options to deploy. Prior to deploying a specific resource option, TVA would conduct an appropriate site or project-specific environmental review that tiers off of Energy Vision 2020.³³

³⁰ Watts Bar FSEIS 2007 pp. S-1 and S-2

³¹ Federal Register 2009 pp. 28323.

³² Energy Vision 2020 1995 TD6. See Option 9.1.4.1, p. T6.42.

³³ Federal Register 1996 p. 7574

In the FSEIS, TVA attempts to justify its departure from the 1995 IRP on the basis that:

TVA considered a number of alternatives to constructing and operating WBN, including the No Action Alternative, in its 1972 FES. In December 1995, TVA issued the IRP FEIS (TVA 1995a). As described in Section 1.3 of this document, the IRP FEIS analyzed a portfolio of options for meeting TVA's future power needs that were derived from the best strategies identified during a two-year process with extensive public input. The environmental impacts of energy resource options were evaluated as part of the IRP FEIS. Because of uncertainties about performance and cost, however, completion of WBN Unit 2 was not included in the portfolio of resource options selected by TVA for implementation. Keeping open alternatives that would meet the goals and objectives of the IRP FEIS, TVA did, however, reserved [sic] for future consideration completing WBN Unit 2. TVA is now, in the context of this SEIS process, reconsidering completion of WBN Unit 2. This is in large part due to the actual operating experience with TVA's nuclear plants which have achieved a capacity factor of 90 percent, a substantial improvement compared to what was projected in the IRP FEIS (67 percent) (see Section 1.3). In tiering off the original 1972 FEIS, the IRP FEIS, and the balance of the environmental record pertinent to WBN, this FSEIS identifies no new alternatives or resource options beyond those already addressed in those documents.³⁴

But TVA can't have it both ways: it cannot rationally rely on the IRP and related studies for the consideration of alternatives, and at the same time ignore those studies because they reject WBN Unit 2 as a viable option for TVA's energy portfolio during the years 1995-2020. If TVA intends to reject the IRP analysis and substitute another, then it must provide that analysis in the FSEIS or wait and re-do the FSEIS after the IRP process it has started in 2009 is complete (see below). Further, as discussed above, the current economic crisis has made even the small amount of information about and projections of electricity sales in the FSEIS entirely obsolete.

The TVA is obligated to follow the elements of the preferred portfolio in the 1996 ROD unless there is a documented and major reason to diverge, for which economic and environmental reasons must be established. But that rationale would require either detailed analysis in the FSEIS or the updating of the IRP decision to include WBN Unit 2 as an element of the portfolio.

D. Outdated Nature of FSEIS Demonstrated by TVA Plan to Update IRP

TVA's own documents show that it has already established a decision-making process for updating the economic and alternatives analyses of the 1995 IRP. As TVA recognizes, in light of the significant changes that have occurred since publication of the 1995 IRP and its associated 1996 Record of Decision, a revised IRP is needed to revisit cost and impact questions and also address the mix of resources required by TVA going forward. On June 15, 2009, the TVA published a notice in the Federal Register soliciting public input on the scope of such an IRP and the associated environmental impact statement.³⁵ According to this Federal Register notice, the "preliminary" questions that the new IRP should address, and on which TVA has sought public comment, are:

³⁴ Watts Bar FSEIS 2007 p. 19

³⁵ Federal Register 2009 pp. 28322-28325

- * How should TVA measure its success in the future?
- * *Should the current power generation mix (e.g., coal, nuclear power, natural gas, hydro, renewables) change? If so, how?*
- * *Should renewable power be available and added in the Valley at a significant scale? If so, how?*
- * How should energy efficiency and demand response be considered in planning for future energy needs and how can TVA directly affect electricity usage by consumers?
- * What stewardship activities should TVA focus on over the next 10–20 years?
- * *And how will all of this affect reliability and the price we pay for electricity?*³⁶

The above quote makes it very clear and explicit that TVA is not at present in a position to provide answers to the above questions, including whether new nuclear power reactors should be included in its generation portfolio or whether existing partially complete reactors like WBN Unit 2, should be completed. TVA will not be in a position to do so until it completes the IRP process and provides answers to these questions in the present context.

The present context is, in many ways, like the period between the mid-1970s and the early 1980s when TVA's demand projections were so far off course. It was a time of rapidly changing and volatile fuel prices, a time of new national energy policies, a time when all aspects of the energy situation from energy security to nuclear proliferation and environmental impacts are being re-evaluated. Moreover, the importance of the climate issue is now far greater than it was, as demonstrated by the recent passage by the House of Representatives of sweeping legislation that, if enacted into law in anything like its present form, will affect everything from fuel prices to the efficiencies of residential and commercial buildings.³⁷ A 30 percent improvement in new building efficiency after 3 years and a 50 percent improvement in less than ten years will make an enormous impact on electricity demand, the more so in the TVA region, where space and water heating are more oriented to electricity than is typical for the whole country. This one factor alone would necessitate a complete revision of TVA's demand projections. The Federal Register notice for the new IRP process recognizes the importance of the new situation, including climate change, which is mentioned three times in a four-page notice.

Further, it is clear that conditions have changed dramatically since 1995. We have already cited climate legislation, which, if passed and enacted into law, will profoundly affect the energy scene. Specifically, electricity demand growth will likely be considerably dampened. Further, the present economic crisis is deep, unlike the economically prosperous times of the mid-1990s.

Since the new IRP will also consider the mix of generation resources and the balance of generation with efficiency (in the context of the smart grid that the TVA is developing), a full reassessment of renewable energy technology is also needed.

³⁶ Federal Register 2009 p. 28324, italics added.

³⁷ For instance, the efficiency of new residential buildings is mandated to improve by 50 percent relative to the baseline code by 2014, 50 percent by 2017, and 70 percent by 2029. Commercial building efficiency is mandated to improve by the same amounts with a one year delay relative to the residential dates. (HR 2454 2009, Section 304 (a)(1))

E. Overall Conclusions Regarding the Need for the Project and Consideration of Alternatives

The analysis in this report shows that the 1995 IRP is obsolete and cannot be used as the basis for deciding on electricity system planning or spending large sums of money on any single project, such as Watts Bar Unit 2 completion. The TVA has acknowledged as much by launching a new IRP process in June 2009 which seeks to establish, among other things, what the mix of TVA generation should be. The 1972 EIS, prepared before the first energy crisis (which was in 1973-1974) is hopelessly outdated and TVA's own analysis in the 1995 IRP had already established that.

Besides the various energy crises that have afflicted the United States since 1973, the climate crisis and impending legislation on energy and climate have also fundamentally changed the situation. For instance, drastic increases in energy efficiency starting in 2012 and continuing on to 2030, by which time new building efficiency is supposed to increase 70 percent according to House passed legislation, mean that forecasts of demand have to be reconsidered with new parameters. In addition there have been vast technological changes in renewable technology and there are currently ongoing basic changes in the management of the grid, through adoption of smart grid approaches. The TVA has just embarked on this process in June 2009, pursuant to the 2007 Energy Independence and Security Act.

This FSEIS does not give any systematic consideration to these basic factors. Even the modest discussion in the FSEIS of electricity projections to the year 2015 have been rendered moot by the economic crisis. TVA electricity sales in 2009 are declining and are on a course to revert to 2004 or 2005 levels, which would make it lower than the lowest level projected in the FSEIS.

The TVA itself has acknowledged the severity of the problem in its latest quarterly filing with the Securities and Exchange Commission. Indeed, the present circumstances point to a repeat of the problems of the 1970s when the TVA kept forecasting business and usual load growth or something close to it, while demand suddenly became static or even dropped for some time, and did not go significantly beyond the peak in the mid-1970s for over a decade-and-a-half. (see Figure 8, at end of text, from TVA's 1995 IRP).

Major changes in technology, in the global and U.S. energy economies as a result of climate change considerations, and in the U.S. and regional TVA economies as a result of a severe and steep recession all indicate that the need for the plant has not been established. On the contrary, they point in the direction that the plant is not needed.

The process that the TVA has launched on June 15, 2009 to create a new IRP is the right one and it asks the kinds of questions that need to be answered before a decision is made to pursue large conventional fossil fuel or nuclear generation.

Figures

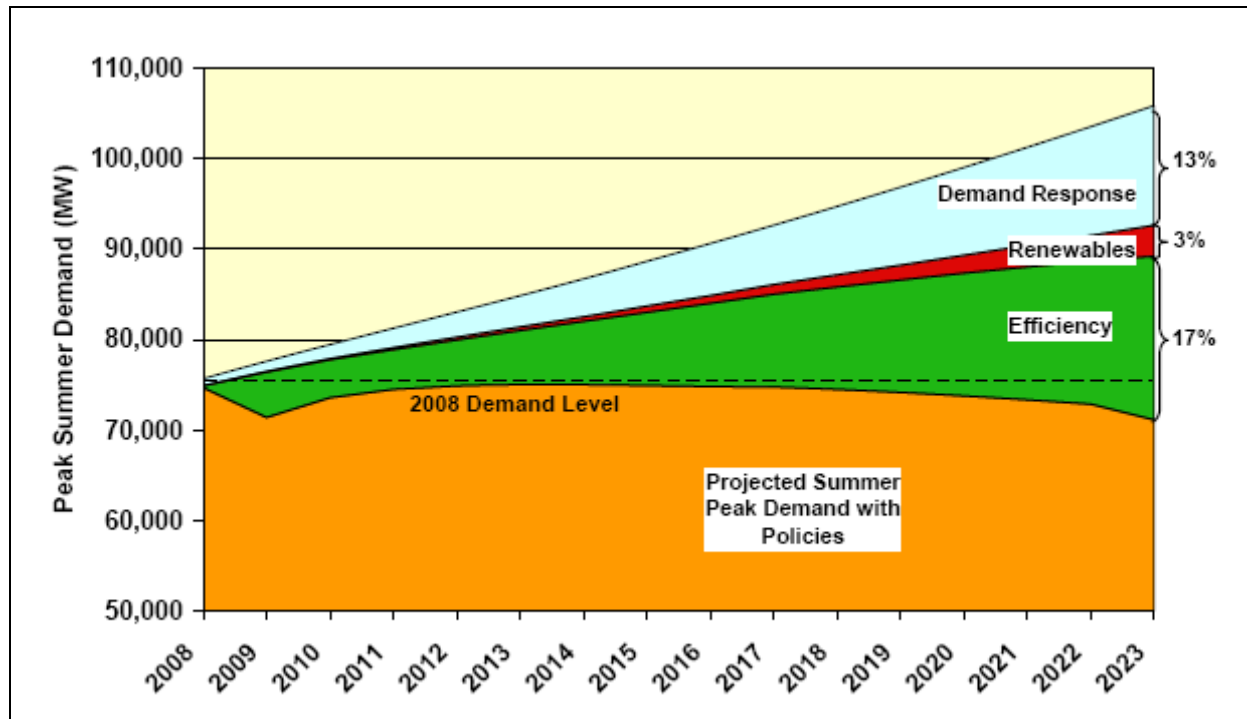


Figure 1: Fraction of summer peak demand that can be met with demand response, efficiency, and renewable resources

Source: Reproduced from ACEEE 2007 page ix, with permission

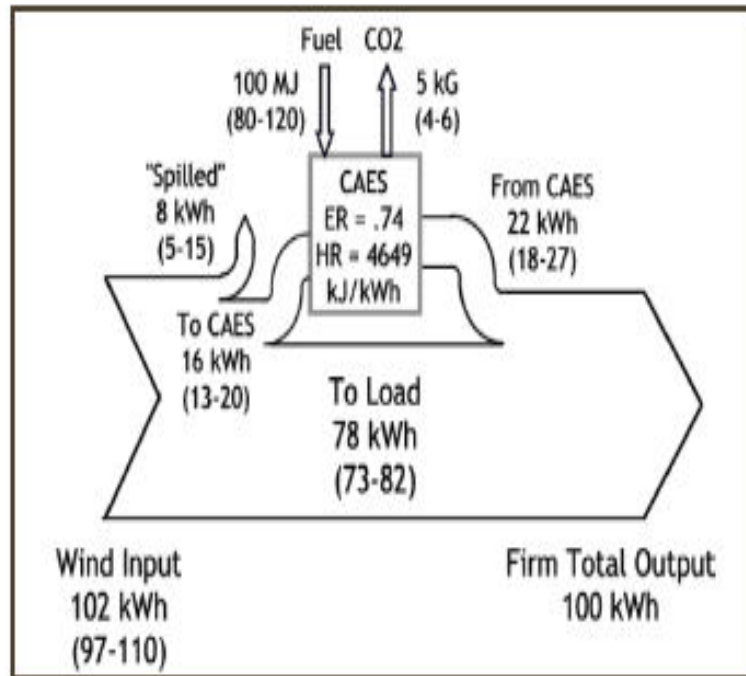


Figure 4: Energy Flow through a Baseload Wind Power Plant

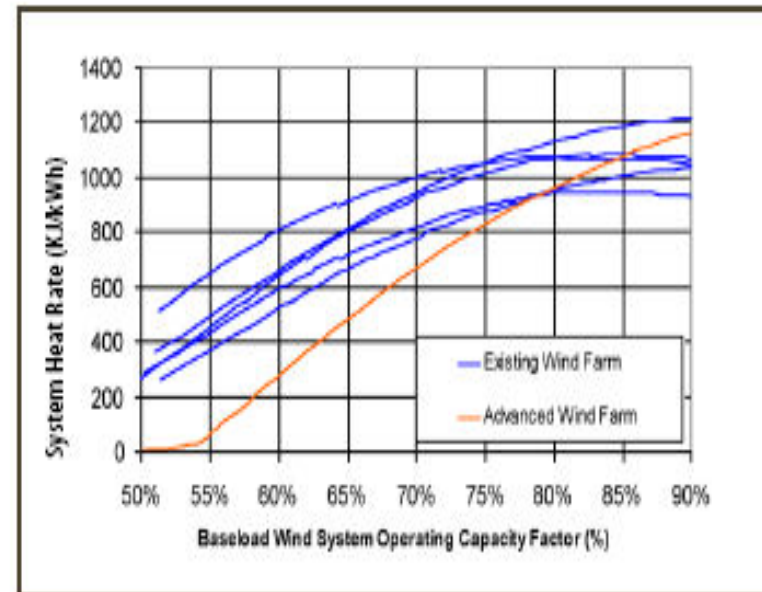


Figure 5: Baseload Wind Plant Fuel Requirements

Figures 2 and 3: Baseload wind with CAES

Source: National Renewable Energy Laboratory (NREL 2006)

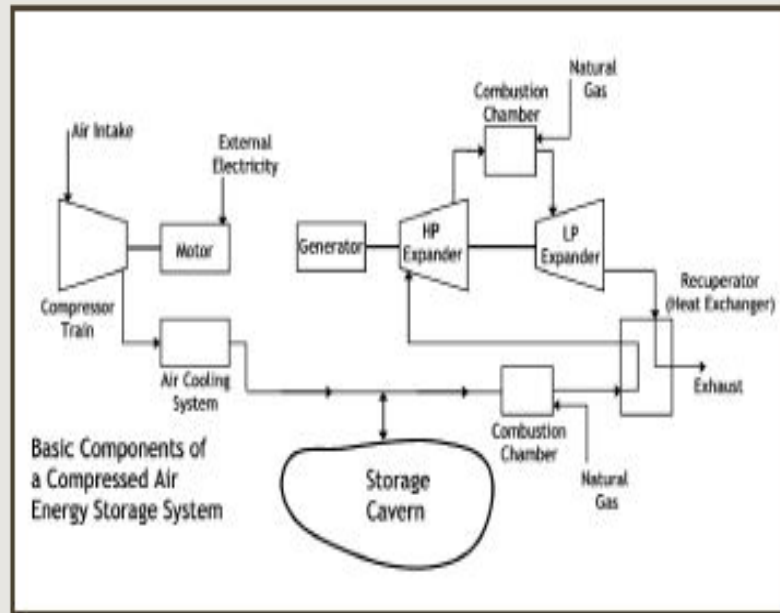


Figure 2. Basic Components of a Compressed Air Energy Storage System

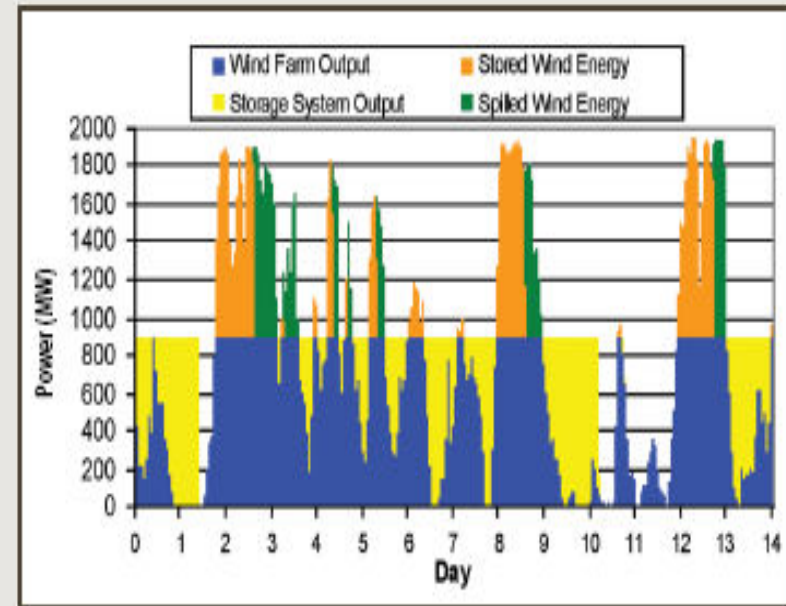


Figure 3. Sample Baseload Wind Generator Output (Target Output = 900 MW)

Figures 4 and 5: Schematic for wind plus CAES and power supply to the grid

Source: National Renewable Energy Laboratory (NREL 2006)

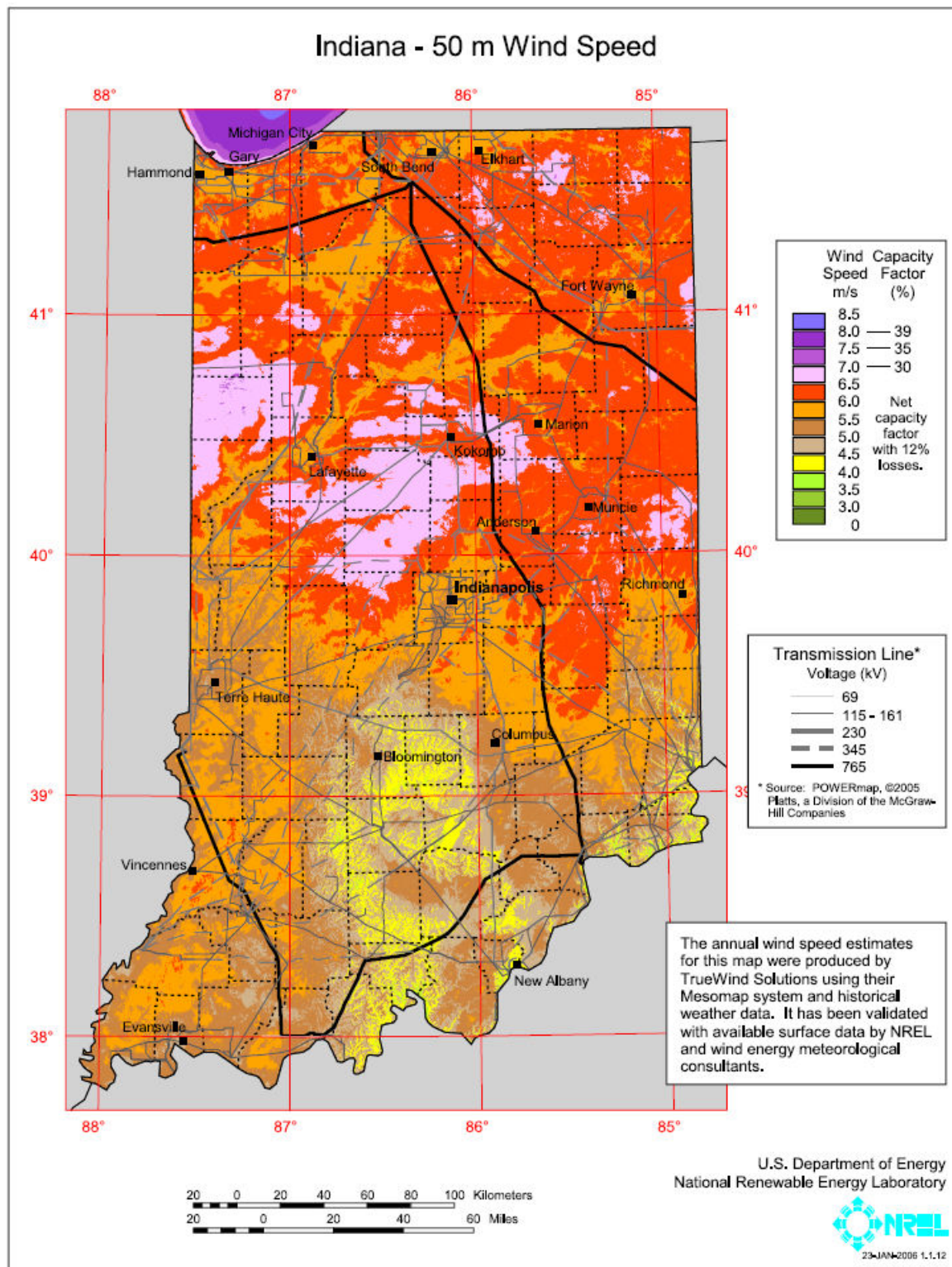


Figure 6: Indiana Wind Map, 50 meters

Source: National Renewable Energy Laboratory (NREL 2008 page 25, and <http://www.in.gov/oed/files/windpower1-1-12speed50mcap.pdf>)

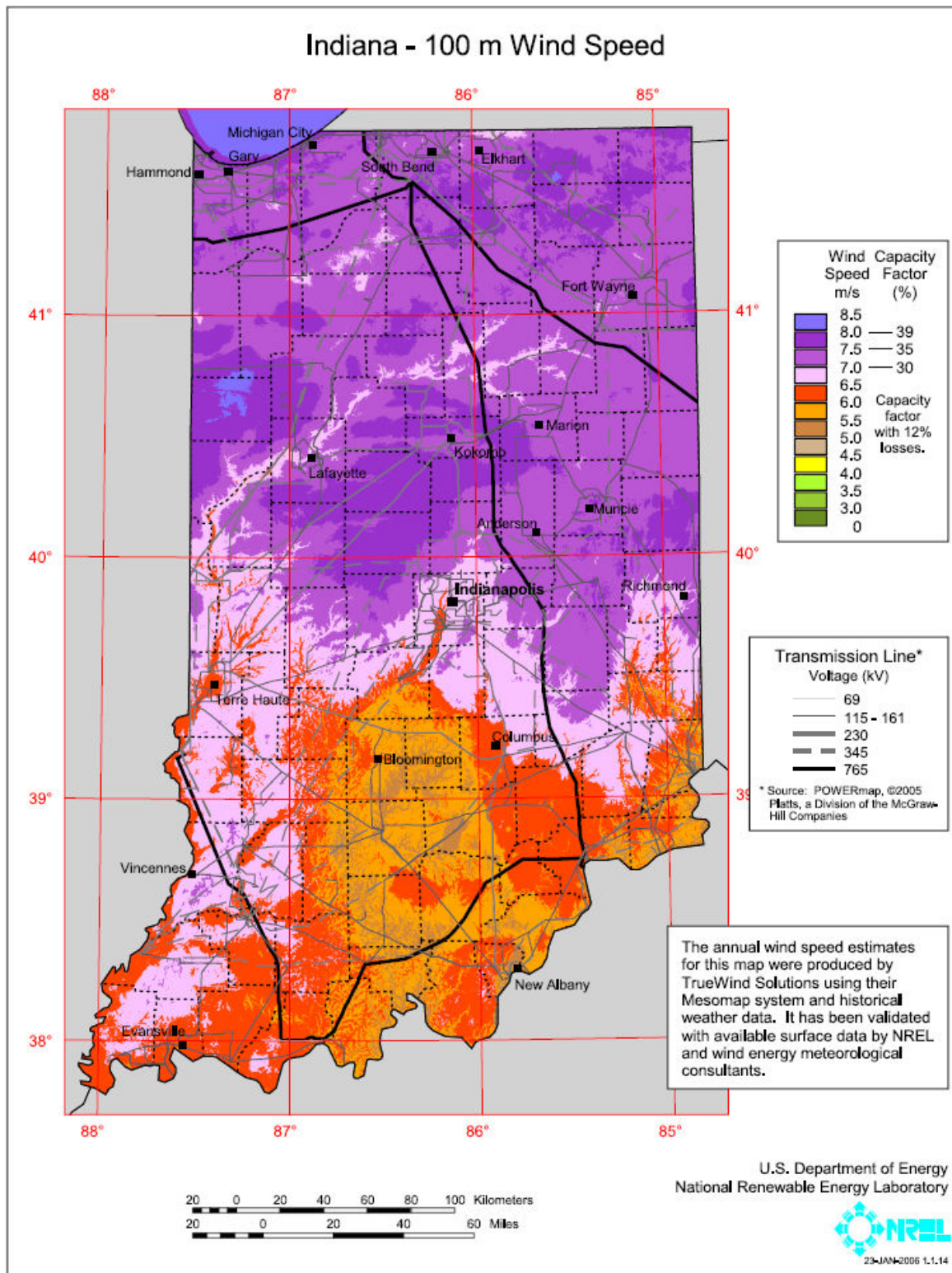


Figure 7: Indiana wind map, 100 meters

Source: National Renewable Energy Laboratory (NREL 2008 page 25, and <http://www.in.gov/oed/files/windpower1-1-14speed100mcap.pdf>)

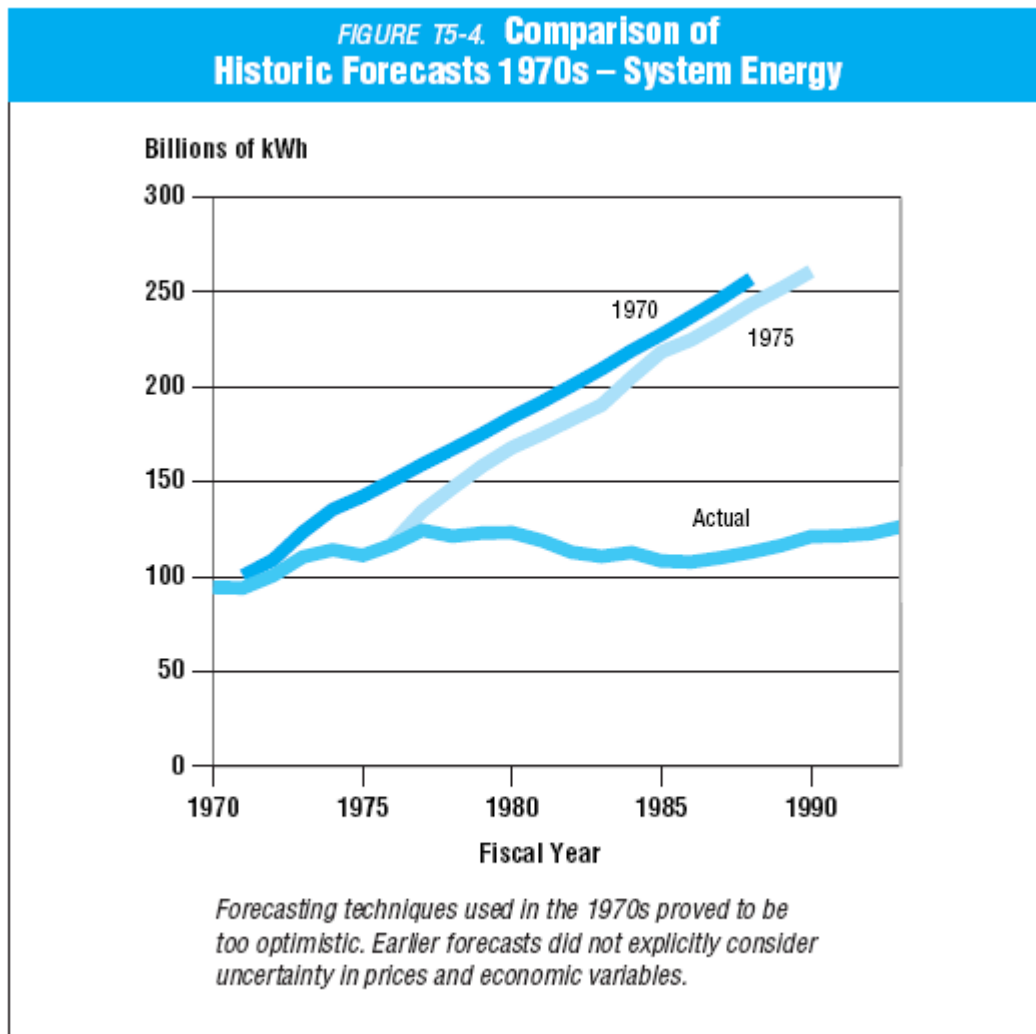


Figure 8: TVA 1970 and 1975 forecasts compared to actual electricity use

Source: Energy Vision 2020 1995 TD5 p. T5.3

References

- ACEEE 2007 R. Neal Elliott, Maggie Eldridge, Anna M. Shipley, John "Skip" Laitner, Steven Nadel, Alison Silverstein, Bruce Hedman, and Mike Sloan. *Potential for Energy Efficiency, Demand Response, and Onsite Renewable Energy to Meet Texas's Growing Electricity Needs*. Report Number E073. Washington, DC: American Council for an Energy-Efficient Economy, March 2007. On the Web at <http://aceee.org/pubs/e073.pdf?CFID=1237698&CFTOKEN=35643136>.
- AWEA 2009 American Wind Energy Association. *American Wind Energy Association Annual Wind Industry Report Year Ending 2008*. Washington, DC: AWEA, 2009. On the Web at <http://www.awea.org/publications/reports/AWEA-Annual-Wind-Report-2009.pdf>.
- BLS 2009 AL U.S. Bureau of Labor Statistics. *Databases: Local Area Unemployment Statistics: Alabama*. Washington, DC: BLS, July 8, 2009. On the Web at http://data.bls.gov/PDQ/servlet/SurveyOutputServlet?data_tool=latest_numbers&series_id=LASST01000003.
- BLS 2009 TN U.S. Bureau of Labor Statistics. *Databases: Local Area Unemployment Statistics: Tennessee*. Washington, DC: BLS, July 8, 2009. On the Web at http://data.bls.gov/PDQ/servlet/SurveyOutputServlet?data_tool=latest_numbers&series_id=LASST47000003.
- EIA 2001 United States. Department of Energy. Energy Information Administration. *Emissions of Greenhouse Gases in the United States 2000*. DOE/EIA-0573(200). Washington, DC: DOE, EIA, Office of Integrated Analysis and Forecasting November 2001. Links on the Web at <http://www.eia.doe.gov/oiaf/1605/archive/gg01rpt/index.html>. Full report at <http://www.eia.doe.gov/oiaf/1605/archive/gg01rpt/pdf/057300.pdf>.
- Energy Vision 2020 1995 Tennessee Valley Authority. *Energy Vision 2020: Integrated Resource Plan, Environmental Impact Statement*. [Knoxville]: TVA, December 1995. On the Web at <http://www.tva.gov/environment/reports/energyvision2020/index.htm>.
- Energy Vision 2020 1995 TD5 Tennessee Valley Authority. *Energy Vision 2020: Integrated Resource Plan, Environmental Impact Statement, Volume 2, Technical Document 5, Load Forecast*. [Knoxville]: TVA, December 1995. On the Web at http://www.tva.gov/environment/reports/energyvision2020/ev2020_vol2td5.pdf.
- Energy Vision 2020 1995 TD6 Tennessee Valley Authority. *Energy Vision 2020: Integrated Resource Plan, Environmental Impact Statement, Volume 2, Technical Document 6, Supply-Side Options*. [Knoxville]: TVA, December 1995. On the Web at http://www.tva.gov/environment/reports/energyvision2020/ev2020_vol2td6.pdf.
- Federal Register 1996 Tennessee Valley Authority. "Integrated Resource Plan. Issuance of Record of Decision." *Federal Register* v. 61, no. 40 (February 28, 1996), p. 7572-7575. On the Web at <http://frwebgate5.access.gpo.gov/cgi-bin/PDFgate.cgi?WAISdocID=06939550201+0+2+0&WAIAction=retrieve>.
- Federal Register 2009 Tennessee Valley Authority. "Environmental Impact Statements; Integrated Resource Plan. Notice of Intent." *Federal Register* v. 74, no. 113 (June 15, 2009), pp. 28322-28325. On the Web at <http://frwebgate3.access.gpo.gov/cgi-bin/PDFgate.cgi?WAISdocID=0698885325+0+2+0&WAIAction=retrieve>.

- Federal Register 2009b Tennessee Valley Authority. "Energy Efficiency and Smart Grid Standards. Notice of consideration of energy efficiency and Smart Grid standards." *Federal Register* v. 74, no. 121 (June 25, 2009) pp. 30360-30361. On the Web at http://www.tva.gov/purpa/federal_register_6-25-09.pdf.
- HR 2454 2009 *American Clean Energy and Security Act of 2009. HR 2454, 111th Congress, 1st Session. An Act to create clean energy jobs, achieve energy independence, reduce global warming pollution and transition to a clean energy economy.* On the Web at <http://thomas.loc.gov/cgi-bin/bdquery/z?d111:HR02454>: & text as passed by the U.S. House of Representatives on June 26, 2009, at http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=111_cong_bills&docid=f:h2454eh.txt.pdf.
- NRC 1995 U.S. Nuclear Regulatory Commission. *Final Environmental Statement Related to the Operation of Watts Bar Nuclear Plant, Units 1 and 2.* Docket Nos. 50-390 and 50-391, Tennessee Valley Authority. NUREG-0498, Supplement No. 1. Washington, DC: NRC, Office of Nuclear Reactor Regulation, April 1995. On the Web at http://www.tva.gov/environment/reports/wattsbar2/related/april_1995.pdf.
- NREL 2006 Paul Denholm. *Creating Baseload Wind Power Systems Using Advanced Compressed Air Energy Storage Concepts.* CU Energy Initiative/NREL Symposium, University of Colorado, Boulder. NREL/PO-640-40674. Golden, CO: National Renewable Energy Laboratory, October 3, 2006. On the Web at <http://www.nrel.gov/docs/fy07osti/40674.pdf>.
- NREL 2008 National Renewable Energy Laboratory. *20% Wind Energy by 2030: Increasing Wind Energy's Contribution to U.S. Electricity Supply.* DOE/GO-102008-2567. [Washington, DC]: U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, July 2008. Links on the Web at http://www1.eere.energy.gov/windandhydro/wind_2030.html lead to full text at <http://www1.eere.energy.gov/windandhydro/pdfs/41869.pdf>.
- TVA 1972 Tennessee Valley Authority. Office of Health and Environmental Science. *Final Environmental Statement, Watts Bar Nuclear Plant Units, 1, 2, and 3.* TVA-OHES-EIS-72-9. Chattanooga, TN: TVA, November 9, 1972. On the Web at http://www.tva.gov/environment/reports/wattsbar2/related/nov_1972.pdf.
- TVA 2008 Tennessee Valley Authority. *TVA Reports Increased Operating Revenues in 2008 Annual Report.* Knoxville: TVA, December 16, 2008. On the Web at http://www.tva.gov/news/releases/octdec08/operating_revenues.htm.
- TVA 2009 Tennessee Valley Authority. *TVA Reports 2009 Fiscal Year Second Quarter Results.* Knoxville: TVA, May 1, 2009. On the Web at <http://www.tva.gov/news/releases/aprjun09/2q.htm>.
- TVA SEC 2008 Tennessee Valley Authority. *Securities and Exchange Commission...Form 10-K, Annual Report Pursuant to Section 13, 15(d), or 37 of the Securities Exchange Act of 1934, For the fiscal year ended September 30, 2008.* Commission file number 000-52313. On the Web at <http://www.sec.gov/Archives/edgar/data/1376986/000137698608000067/form10-k.htm>.
- TVA SEC 2009 Tennessee Valley Authority. *Securities and Exchange Commission...FORM 10-Q, Quarterly Report Pursuant to Section 13, 15(d), or 37 of the Securities Exchange Act of 1934, For the quarterly period ended March 31, 2009.* Commission file number 000-52313. On the Web at <http://www.sec.gov/Archives/edgar/data/1376986/000137698609000044/tva10q.htm>.

- TVA Staff Report 2009 Tennessee Valley Authority. *Staff Report on Preliminary Recommendations on the Four PURPA Standards Under Section 111(D) of the Public Utility Regulatory Policies Act Pursuant to the Energy Independence And Security Act of 2007*. [Knoxville]: TVA, June 2009. On the Web at http://www.tva.com/purpa/pdf/staff_response_to_2007_eisa_purpa_standards-final_.pdf.
- TVA Strategic Plan 2007 Tennessee Valley Authority. *Strategic Plan 2007: Serving the Valley*. [Knoxville]: TVA, 2007. On the Web at http://www.tva.gov/stratplan/tva_strategic_plan.pdf.
- Watts Bar FSEIS 2007 Tennessee Valley Authority. *Final Supplemental Environmental Impact Statement: Completion and Operation Of Watts Bar Nuclear Plant Unit 2, Rhea County, Tennessee*. Spring City, TN: TVA, June 2007. Submitted to the U.S. Nuclear Regulatory Commission on February 15, 2008, with letter from Masoud Bajestani (Watts Bar Unit 2 Vice President). ML080510469. Both on the Web at http://adamswebsearch2.nrc.gov/idmws/doccontent.dll?library=PU_ADAMS^PBNTAD01&ID=080590142.
- Watts Bar Web site 2009 Tennessee Valley Authority. *Watts Bar Nuclear Plant*. On the Web at <http://www.tva.gov/sites/wattsbar-nuc.htm>.
- Wind Power 2009 Wind Power. *Wind Turbines and Wind Farms Database*. Buc, France: The Wind Power, [2009]. On the Web at <http://www.thewindpower.net/wind-turbine-datasheet-223-enercon-e126-6000.php>.
- Xcel Energy 2008 Xcel Energy. *SmartGridCity™: Design Plan for Boulder, Colo*. Utility Innovations. [Minneapolis]: Xcel Energy, 2008. On the Web at <http://smartgridcity.xcelenergy.com/media/pdf/SmartGridCityDesignPlan.pdf>.

July 11, 2009

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of)	
Tennessee Valley Authority)	
Completion and Operation License)	Docket No. 50-391OL
Watts Bar Nuclear Plant Unit 2)	
_____)	

DECLARATION OF SHAWN PAUL YOUNG, PH.D.

Under penalty of perjury, I, Shawn Paul Young, declare as follows:

I. STATEMENT OF PURPOSE AND PROFESSIONAL QUALIFICATIONS

1. My name is Shawn Paul Young. My business address is 1008 Jefferson Court, Moscow, ID 83843. I have been retained by the Petitioners as a private consultant in this matter. The purpose of my declaration is to provide my professional opinion regarding the inadequacies of the environmental studies prepared by the Tennessee Valley Authority ("TVA" or "Applicant") to address the environmental impacts of the proposed Watts Bar Nuclear Power Plant Unit 2 ("WBN2") on aquatic organisms in the Tennessee River.

2. I am a fisheries biologist and am currently employed as a Research Assistant Professor at the University of Idaho, Moscow, Idaho. A copy of my curriculum vitae attached to this declaration.

3. I received a B.S. in Environmental Studies from Northland College; a M.S. in Aquaculture, Fisheries, and Wildlife Biology from Clemson University; and a Ph.D. in Fisheries and Wildlife Sciences from Clemson University. I have twelve years experience researching the effects of human activities on fisheries and aquatic ecosystems. In addition to my professional

qualifications, I have been an avid outdoorsman, fishing, hunting, and enjoying nature in every manner since my early childhood.

4. I previously held teaching positions at the University of Idaho, and Purdue and Clemson Universities with course responsibilities in the topics of Fish Ecology, Limnology/Aquatic Ecology, Fisheries Management, Environmental Conservation, and Watershed Hydrology. I have written 27 peer-reviewed publications relevant to fisheries and aquatic ecology. I have been consulted by public, state, federal, and academic sectors in the subject area of fish and aquatic ecology. I have presented scientific presentations at numerous professional meetings, academic seminars, and citizen fishing association functions.

5. I have been consulted on similar matters as an expert in fisheries and aquatic resources for the following facilities:

Bellefonte Nuclear Plant Units 1 & 2 (Tennessee River, Alabama)

Bellefonte Nuclear Plant Units 3 & 4 (Tennessee River, Alabama)

Vogtle Nuclear Plant (Savannah River, Georgia)

North Anna Nuclear Plant (North Anna / Pamunkey River, Virginia)

Tillery Dam Re-licensing (Yadkin-Pee Dee River, North Carolina)

II. DOCUMENTS REVIEWED

1. I am familiar with the following documents related to TVA's application for the completion and operation of WBN2, including documents for WBN Units 1 & 2:

- TVA Final Supplemental Environmental Impact Statement – Completion and Operation of Watts Bar Nuclear Plant Unit 2 (2008) (“FSEIS”)

- Letter from Masoud Bajestani, TVA, to NRC re Watts Bar Nuclear Plant (WBN) – Unit 2 -- Final Supplemental Environmental Impact Statement – Request for Additional Information (TAC MD8203) (July 2, 2008) (“2008 TVA RAI Response”)
- TVA, Fish Impingement at Watts Bar Nuclear Plant Supplemental Condenser Cooling Water Intake Structure During 2005 through 2007 (2007). (“TVA 2007 Fish Impingement Study”) (attached to 2008 TVA RAI Response).
- TVA, Watts Bar Nuclear Plant Supplemental Condenser Cooling Water Intake Fish Monitoring Program (2001) (“TVA 2001 SCCW Fish Monitoring”)
- TVA Environmental Assessment, Watts Bar Nuclear Plant Supplemental Condenser Cooling Withdrawal (1998) (“TVA EA for SCCW”)
- NRC Final Environmental Statement Related to the Operation of Watts Bar Nuclear Plant Units 1 and 2 (1995) (“1995 NRC FEIS”)
- TVA Final Supplemental Environmental Review – Operation of Watts Bar Nuclear Plant (1995)
- NRC Final Environmental Statement Watts Bar Nuclear Plant Units 1 and 2 (1978) (“1978 NRC FEIS”)
- TVA Environmental Statement Watts Bar Nuclear Plant Units 1 and 2 (1972) (“1972 TVA FEIS”).

2. I have reviewed materials and data provided within the documents identified above that describe the water intake, water consumption, and thermal discharge from Watts Bar Nuclear Plant Unit 1 (“WBN1”) and Unit 2 (“WBN2”) into the Tennessee River and subsequent potential impacts on the aquatic resources including fish and mussel assemblages of the Tennessee River.

III. STATEMENT OF PROFESSIONAL OPINION REGARDING ADEQUACY OF TVA ENVIRONMENTAL STUDIES TO ADDRESS THE ENVIRONMENTAL IMPACTS OF THE PROPOSED WATTS BAR 2 NUCLEAR POWER PLANT ON AQUATIC ORGANISMS

A. Overview

1. TVA claims that the cumulative impacts of WBN2 on aquatic ecology will be insignificant (FSEIS Table S-1 at page. S-2, and Table 2-1 at page. 30). TVA's conclusion is not reasonable or adequately supported, in three key respects. First, TVA's conclusion that cumulative impacts will be insignificant is based on the faulty premise that the aquatic ecosystem that will be affected by WBN2 is currently in a good state of health. In fact, data in TVA's own environmental studies, as well as available literature, show that the health of the Tennessee River ecosystem, including Lake Chickamauga where WBN1 and 2 are located, is damaged, fragile, and quite vulnerable to the additional impacts that would be posed by WBN2's cooling water system.

2. Second, TVA relies on outdated and inadequate data to predict the effects of WBN2's cooling system on the eggs and larvae of fish and other aquatic organisms. In particular, the FSEIS understates the potential impacts of the coolant intake system (*i.e.*, entrainment and impingement) and the thermal impacts of the coolant discharge system on fish and benthic organisms, by relying on poor or outdated data, a distorted interpretation of data, and assumptions and extrapolations in lieu of recent monitoring studies.

3. Finally, TVA does not adequately address the cumulative impacts of WBN2 in conjunction with the impacts of the numerous water impoundments on the Tennessee River, or with other industrial facilities such as the ten fossil fuel-burning plants, the six nuclear reactors that are already in operation, and the five additional reactors for which TVA has sought operating licenses. Each of these facilities affects the Tennessee River continuum. That is, each

facility not only affects the immediate environment, but those changes are then felt throughout the river as a domino effect. The portion of the Tennessee River in the vicinity of WBN is an important part of the river continuum, as are all other segments of the river. Each segment has its own complex ecological balance that is required to support a diverse population of fish and other organisms, providing different habitats needed at different life history stages that must match available food and habitat needs in time and space. Each new industrial facility that is added to the environment will compound the existing disruptions to these interrelated aquatic ecosystems, and further remove the Tennessee River from any semblance of the natural state which would be necessary to restore or even halt the deterioration of the hundreds of declining, threatened, and endangered aquatic species in the Tennessee River Basin.

4. In summary, I do not believe that the FSEIS provided a reasonably accurate or adequate assessment of the environmental impacts of WBN2 to the aquatic environment.

B. Background Information Regarding the Aquatic Environment of the Tennessee River Basin

1. The Tennessee River is considered to be the single most biologically diverse river system for aquatic organisms in the United States, supporting at least 205 fish species representing 29 families (Etnier and Starnes 1993; Simon and Wallus 2006) including 32 fish species that are found only in the Tennessee River (Simon and Wallus 2006).

2. However, the Tennessee River also harbors the highest number of imperiled species of any large river basin in North America, with 57 fish species and 47 mussel species considered to be “at-risk” (Master et al. 1998). Many fish and mussel populations throughout the entire Tennessee River Basin -- including the Upper Tennessee River, which encompasses Chickamauga Reservoir -- are greatly reduced from their historical numbers. Just in the upper-basin, 15 fish species are federally listed as endangered or threatened and 50 fish species are

listed under management categories used by four states for protection of sensitive species.

(Hampson et al. 2000). Also in the upper-Tennessee River basin, 30 freshwater mussel species are under Federal protection and 52 mussel species are listed for protection by four states (Hampson et al. 2000).

3. Recently, TVA's *Energy Vision 2020* publication (page 3.32) stated that an astonishing 100 species of animals in the TVA region are either listed as endangered or threatened species or formally proposed for such listing by the United States Fish and Wildlife Service, and an additional 380 species in the TVA region have been identified by the United States Fish and Wildlife Service as candidates for listing.

C. Inadequate Discussion and Inaccurate Portrayal of Existing Conditions

1. In Chapter 3 of the FSEIS, TVA claims to address the changes in the aquatic environment that have taken place since TVA first addressed the impacts of building and operating the WBN nuclear power plant in 1972 (page 33). Section 3.2 addresses the characteristics of the WBN site's aquatic environment and biota.

2. The only information in Section 3.2 regarding the health of fish is a statement that a TVA aquatic monitoring program begun in 1993, called "Vital Signs," shows that "the quality of the fish community in the vicinity of the WBN site has remained relatively constant with an average rating of 'good'" (page 55).

3. TVA misinterprets its own vital signs monitoring data. Table C.3 of the FSEIS (page 151) presents the overall Reservoir Fish Assemblage Index score, based on the Vital Signs monitoring program, with a higher RFAI score signifying a healthier fish assemblage. The table shows a steadily declining RFAI score between 1993 and 2005, from 52 to 42 for the area downstream of WBN1 and 2.

4. In characterizing fish health as “good,” TVA fails to identify and discuss an alarming trend of declining fish species in Chickamauga Reservoir. Within Chickamauga Reservoir, there was a 24% decline of freshwater fish captured in TVA sampling during 1991-1996 compared to 1970-1973. This evidence of the poor state of the native fish community in the Chickamauga Reservoir portion of the Tennessee River (site of WBN) may be found in the 1978 WBN Units 1 & 2 FEIS (Table C-21) and the 2008 WBN Unit 2 FSEIS (Table 3.3.1). In comparing fish community surveys from 1970-1973 and 1991-1996 (the most recent list of fish species occurring in Chickamauga Reservoir found in the FSEIS), the number of fish species captured in Chickamauga Reservoir declined from 60 to 46, a 24% decline. Fish species intolerant to ecosystem disturbance such as highfin carpsucker, silver redhorse, shorthead redhorse, and river redhorse were absent from the 1991-1996 survey. These species are adversely affected by habitat alteration, blocked migration, loss of spawning habitats, altered flow-regimes (Pflieger 1975; Etnier and Starnes 1993; Rohde et al. 1994) and by disruption of early life history stages by altered flow-regimes, impingement, and entrainment of eggs, larvae, and juveniles caused by power-plants (Etnier and Starnes 1993; Marcy et al. 2005). Also, blackstripe topminnow, blackspot topminnow, rainbow darter, and orangespot sunfish were not captured. Literature reports disappearances of taxonomic groups of which these species belong typically occurs in fragmented and degraded rivers (Angermeier 1995).

5. In discussing fish community health, TVA also states that “Average RFAI scores from each site compare favorably with average scores from similar areas in other mainstream Tennessee River reservoirs.” (2008 FSEIS RAI 3.3.1-28 & Table 3.3.2). But those fish communities are in serious decline. For example, within Guntersville Reservoir, located down-river, there has been a 44% decline of freshwater fish captured during 1949-1994 and 2000-2006

TVA sampling (Bellefonte Nuclear Plant, Units 3 and 4, COL Application, ER § 2.4.2.4).

Similar to Chickamauga, fish species no longer found in the Guntersville Reservoir during TVA sampling include highfin carpsucker, silver redhorse, and river redhorse.

6. The steep declines in the health of fish communities in Chickamauga and Guntersville Reservoirs are alarming. They indicate that these fish populations are in poor health, not “good” or “fair” health as euphemistically characterized by TVA. And TVA has not taken the necessary steps to evaluate the contribution of its existing facilities to the fragile health of the fish populations, or how the additional stress from nuclear expansion will exacerbate these precipitous declines.

7. The FSEIS also states that the native mussel population, which the 1995 NRC FEIS had reported to be declining (page 2-26), has remained “relatively constant” (page 55). In Table C-4 of the FSEIS (page 152), TVA gives an “Excellent” score to the benthic invertebrate community, of which freshwater mussels are members, near WBN in 2005.

8. But the data used by TVA to give the mussel population an “excellent” rating is not accurate, because the number of mussel species has declined and the population consists of aging adults that are not successfully reproducing. The FSEIS fails to acknowledge that for the mussel population to remain constant is not a sign of good health, but a sign that the lost mussel species are not being restored, and remaining mussel species are not reproducing. As stated in the 1995 FEIS at page 2-26, “Prior to the impoundments, a total of 64 freshwater mussel species are thought to have occurred near the WBN Site (TVA 1986). In recent years, only 31 mussel species have been recorded in the vicinity of the WBN Site, and only 28 species were reported during the 1988 and 1990 surveys (TVA 1991b).” Other scientific papers report that pre-1960 mussel surveys found 89 species in the lower Tennessee River Basin, and 94 species of

freshwater mussels in the upper Tennessee River (Starnes and Bogan 1988; Vaughan 1997). Since 1960, a 14% decline of mussel species has been reported in the lower basin and a 36% decline of mussel species reported in the upper basin, location of WBN (Starnes and Bogan 1988; Vaughan 1997).

9. In the 1995 FEIS, the NRC stated that the reasons for the decline of the mussels is not known, although it is “reasonable to assume” that impoundment of the river is “largely responsible” (page 2-26). Although neither NRC or TVA claimed to adequately understand the reasons for the mussels’ decline 15 years ago, the FSEIS gives no indication that TVA has given the matter any further thought. The FSEIS contains no discussion of habitat requirements such as temperature tolerance, or of basic ecology that would be reasonable to expect in evaluating potential impacts is presented. For instance, there is no discussion of existing condition of fish species that the glochidia life history stage of freshwater mussels near WBN must attached to and parasitize in order to complete their life cycle. There is potential that modifications to the aquatic environment from Units 1 & 2 may disrupt these mussel/fish-host relationships by displacing or reducing abundance of fish-host species through general avoidance of the altered environment near WBN, or from increased mortality due to entrainment or impingement by water intakes and due to exposure to increased thermal discharge.

10. Fisheries and aquatic invertebrate experts cite the incremental impacts from dams, urbanization, industrialization, and power-generation facilities (including nuclear) as the causes of decline within the Tennessee River and for other major river systems (Etnier and Starnes 1993; Parmalee and Bogan 1998; Marcy et al. 2005). This includes the operation of TVA’s facilities (Etnier and Starnes 1993). While dams may be the primary cause of species decline, they are not the only contributor. Yet, TVA’s environmental studies do not attempt to evaluate,

to any meaningful degree, the contribution of the existing WBN1 cooling system to the declining health of the aquatic ecosystem.

11. Assuming for purposes of argument that TVA's rating system were an adequate measure to monitor changes in aquatic resources, a 24% decline of fish species and a >50% decline in mussels would most certainly rate as 'poor', possibly "fair" at best. Therefore, TVA's over-reliance on these scores to conclude insignificant impacts from operation of WBN should be scrutinized, and raw data should be presented in its entirety to properly evaluate long-term trends and potential impacts from nuclear expansion.

D. TVA's Conclusion That Impacts of WBN2's Cooling Water Intake on Fish are Insignificant is Not Supported by Adequate or Up-to-Date Data.

1. Nuclear power plant cooling systems can kill fish and other aquatic organisms in three principal ways: entrainment, impingement, and thermal impacts. Entrainment occurs when organisms comprising the drift community (aquatic organisms of various life history stages that passively drift in the river flow as means of transport) are pulled from the main water body by the plant cooling water intake pumps into the intake canal and the facility causing mortality. The most vulnerable life history stages for fish species are the egg and larval stages (ichthyoplankton), because they are immobile and cannot avoid being sucked into industrial coolant systems and turbines. Ichthyoplankton usually comprise a substantial portion of the drift community.

2. Impingement occurs when, as water is sucked into the cooling system, juvenile and adult fish collide with screens and filter systems used to keep foreign objects out of the system. TVA's conclusion that potential impacts of the intake system on the environment will be insignificant is not substantiated, and impacts may be large.

3. Fish and benthic organisms also can be injured or killed by thermal impacts of large volumes of heated water that are discharged in the “blowdown” from nuclear power plant cooling systems.
4. The volume and speed at which water is taken into the plant has an effect on how severe are the impacts of entrainment and impingement. The FSEIS and other environmental documents are somewhat inconsistent in their representations regarding changes to the volume and/or speed of water taken in by the WBN plants at the intakes on the Chickamauga and Watts Bar Reservoirs. According to TVA’s 2009 RAI Response (page E1-2), the volume of water delivered to Watts Bar by the SCCW system would not change for dual-unit operation. (The environmental impacts of the SCCW were evaluated for only WBN1, not WBN2 (FSEIS pp. 7-8)). In contrast, the FSEIS states (at page 29) that as a result of WBN2’s operation, water intake would increase by 33 percent, although it would be within the design basis for operation. Whether or not a 33% increase in volume is within the design basis, it could have high significance for the health of the aquatic environment.

Entrainment

5. Given their lack of mobility, fish eggs and most fish larvae cannot escape the intake flow velocity and are sucked into the intake canal and cooling system. Phytoplankton and zooplankton, which constitute important food sources for fish, mussels, and aquatic insects, may also be entrained due to their lack of mobility. Fish and other organisms pass through the plant’s cooling system, suffering injury or death through physical contact, rapid pressure or temperature change, and chemical poisoning from biocides and other chemicals introduced into the water.
6. Knowledge of the ichthyoplankton population distribution in relation to intakes across time and space is very important to an understanding of entrainment impacts, because

ichthyoplankton tend be patchy (high numbers clumped into a specific portion of the water column). This patchy distribution creates a high level of vulnerability to entrainment mortality if the organisms are located near intakes, because they cannot simply avoid the intakes.

7. TVA's conclusion regarding potential impacts of entrainment as a consequence of increasing water intake from combined operation of WBN1 & WBN2 is unsupported because it is *not based on any measure of actual entrainment* at WBN1. The FSEIS presents no post-operational entrainment monitoring for the Condenser Cooling Water ("CCW") or Supplemental Condenser Cooling Water (SCCW) intakes or impingement data from Condenser Cooling Water ("CCW") for WBN1 to support the conclusion water intake from Unit 1 and also cumulative effects of combined operation from Unit 1 & 2 would be insignificant. Despite the fact that WBN1 has been operating since 1996, the FSEIS does not contain any data or other information regarding entrainment and impingement from Condenser Cooling Water intake (CCW) for WBN1.

8. In lieu of relying on an actual field study of ichthyoplankton entrainment at the WBN1 intakes, TVA bases its conclusion of no significant impact on extrapolations from pre-operational ichthyoplankton surveys conducted over 30 years ago during the 1970's (*i.e.*, a pre-operational 1975-76 ichthyoplankton study reported in the NRC's 1978 FEIS) and a general ichthyoplankton survey completed in 1996-97 at the WBN site. Neither study used the appropriate methodology to evaluate actual entrainment by WBN1, nor are the appropriate data from these surveys listed in the FSEIS to support TVA's conclusions concerning adverse impacts.

9. TVA 2001 SCCW Fish Monitoring report (cited in the FSEIS at page 54) also reflects TVA's failure to utilize the appropriate methods to measure entrainment. TVA again did not

measure organisms entrained by the SCCW, and apparently assumes percent entrainment equals percent of river volume withdrawn. TVA only sampled along a transect in Watts Bar forebay near the SCCW intakes, and did not sample organisms actually entrained in the intake structure.

10. In extrapolating from general fish surveys rather than conducting actual entrainment monitoring, TVA did not follow EPA guidance for entrainment monitoring, which calls for sampling at water intake structures to capture entrained organisms in combination with an ichthyoplankton survey of the river near the intake structures (U. S. EPA 1977 page 42). By measuring the number of organisms drifting past the facility and the number of organisms actually entrained by water intakes, TVA could have determined percent of organisms entrained, which then allows for a more accurate evaluation of adverse impacts.

11. TVA further bases its conclusion of insignificant entrainment impacts upon a potentially erroneous assumption: that the distribution of organisms across the river channel and from the surface to the bottom of the river is uniform. TVA bases its assumption on 1975-76 data that are listed in Table C.16 of the NRC's 1978 FEIS. In addition to relying on extremely outdated (i.e., 35 yearsold) data, Table C.16 is faulty because it only lists percent relative abundance of fish larvae at five sampling stations on a transect across the river channel, not the actual number of fish larvae that were captured,. By using percent relative abundance, without also providing the true number of organisms captured near WBN1 water intakes, TVA makes it impossible to determine whether its assumption of a uniform drift distribution is accurate.

12. For example, the table states that "unspecified clupieds" (shad/herring larvae) made up 90% of an unstated total number of organisms captured at the left shoreline adjacent to WBN, and 92% of an unstated total number of organisms captured during sampling near the right bank opposite WBN. The two percents are quite similar; however, 90% and 92% are only relative

numbers, not actual totals. Information about the total number of organisms of each species is needed before one can evaluate the distribution of species across the transect. For example, if the “unspecified clupieds” were 90% of 1,000,000 total fish larvae captured, equaling 900,000, compared to 92% of 100,000 total fish larvae captured, equaling 92,000, then the total “unspecified clupieds” would be a magnitude greater near WBN intakes than on the opposite bank. Thus, the distribution of ichthyoplankton would not be uniform, and the assumption and estimates based on this assumption would be erroneous. If the number of organisms is greater on the riverbank where WBN water intakes are located, then there is a greater probability that numbers of entrained organisms may greatly exceed TVA’s estimated impact of entrainment. But TVA does not provide this information, instead assuming uniform distribution of species.

13. By assuming uniform distribution of organisms across the transect that it samples, TVA assumes entrainment is commensurate with a closed cooling water system. That is the percentage of all organisms drifting past WBN that may be entrained will be equal to the percentage of the river discharge flowing by WBN that is withdrawn for cooling. But this assumption is not reasonable, because fish populations may vary across the river and by depth, just as the mussel population favors one side of the riverbed over the other (1995 NRC EIS page 2-26). Further, egg and larval abundance is patchy across time and space as different species spawn at different times of the year and using different habitats. TVA makes no effort to address the ecology of fish species in Chickamauga Reservoir within the FSEIS.

14. Further, Table C.16 of the NRC’s 1978 FEIS does not give any data for fish eggs. This is an important omission because fish eggs may be found in high abundance during different times of the year and are very vulnerable to entrainment. If captured fish eggs are not included, then entrainment may be greatly underestimated.

15. Given TVA's over-reliance of Table C.16 to form major assumptions and conclusions concerning Units 1 & 2 water intakes, TVA should update and correct the information by obtaining the appropriate data through a field study of entrainment during operation of WBN1, following EPA section 316(b) guidelines. An actual entrainment and impingement study of all water intakes during the annual operation of Unit 1 is a reasonable expectation and the scientifically accepted method to properly evaluate and conclude levels of entrainment. Further, it is reasonable to expect TVA can and should provide such information on an annual basis. TVA maintains a fisheries and aquatic sampling department; therefore, TVA has the means to conduct the proper monitoring studies.

Impingement

16. TVA's impingement data are also inadequate. During 2005-2007, TVA conducted an impingement study on the Supplemental Condenser Cooling Water intake (SCCW) (Watts Bar Nuclear Plant Fish Impingement at Watts Bar Nuclear Plant Supplemental Condenser Cooling Water Intake Structure during 2005 through 2007, Page 5 (2007)). Even though TVA found a rate of impingement that was "much higher than estimated from samples collected during 1975-1976," TVA ended the study and also failed to expand it to the Condenser Cooling Water intake (CCW) for Unit 1. As a result, TVA has failed to monitor or evaluate the negative trend observed in 2005-07 at the SCCW intake, and it has also failed to update the 35-year-old data on which it relies for its conclusions about impingement at the Unit 1 CCW intake.

17. Impingement of fish at the SCCW intakes should not be used to estimate impingement for the entire WBN facility because the intakes are located in the forebay above Watts Bar Dam not immediate to the other intakes on Lake Chickamauga that are below the dam. Existing conditions may be substantially different above the dam in the forebay compared to below the

dam in the tailwater. For instance, a tailwater is characterized by riverine conditions of high flow velocity, intermediate water depth, and hard substrates; whereas, the forebay is deep with low flow velocity and fine sediments. The different habitats support different fish and mussel species, and these species may have differential spawning success in a tailwater versus a forebay habitat. These factors then influence the number and timing of occurrence of different species near the CCW and SCCW intakes.

E. TVA's Conclusion That Thermal Impacts are Insignificant is Not Adequately Supported and is Contradicted by Information Presented in Other EISs.

1. Nuclear reactors require large volumes of cooling water to dissipate heat through evaporative cooling and some waste water from reactor blowdown. The heated wastewater is then discharged back into the river. The thermal discharge forms a plume or mixing zone where the heat from the wastewater dissipates into the cooler river waters. Diffusers installed near the outfalls mix heated discharge with cooler water, creating a mixing zone with elevated temperatures nearest the diffusers and then approach ambient river temperatures at some distance from the diffusers depending on volume of thermal discharge, the temperature of the effluent exiting the facility, ambient temperature of the receiving river, and flow and discharge of the receiving river.
2. TVA states that the thermal impacts of WBN2 on the aquatic environment will be insignificant (FSEIS page 30). But TVA provides no evidence in the form of scientific study or field observation to justify its conclusion. And TVA's conclusion is contradicted by its acknowledgement of the need to relocate mussels in the vicinity of the SCCW discharge (Outfall 113) to avoid mortality from elevated temperatures (2008 TVA RAI Response Section 3.3.3.3 Page 39).
3. A number of basic data sets are missing from TVA's evaluation of thermal impacts.

a. TVA provides no recent data on overall drift community, nor does it provide any data on spatial and temporal distribution of ichthyoplankton in relation to thermal mixing zones. Thus, TVA does not provide any current data of what species are or will be drifting through the thermal mixing zones to come to any conclusion pertaining to adverse impact of thermal discharge. Knowledge of the ichthyoplankton distribution in relation to the thermal discharge across time and space is very important because ichthyoplankton tend to be patchy (high numbers clumped into a specific portion of the water column) which creates a high level of vulnerability to thermal plumes.

b. TVA fails to account for the fact that the size and temperature profile of the mixing zone varies with dam discharge. It is reasonable to expect TVA should have coupled modeling of the thermal discharge plumes under different river flows with ichthyoplankton and mussel distributions to determine effects on the different species across time and space.

c. TVA fails to account for the fact that the depth and volume of outfall 101 (CCW), a bottom-diffuser, and 113 (SCCW), a surface diffuser, are much different. This difference will affect thermal impacts on fish because the horizontal distance of a fish species from WBN and the depth of the water column occupied by a species will influence its probability of exposure to thermal effluent. Also, the changing of mixing zone configuration over time and across space creates higher variability in temperature which may be detrimental to fish and mussels. TVA presents no recent data on temporal or spatial composition of fish of any life history stage and how the various species' life stages may be impacted by thermal discharge from either Outfall 101 or 113.

d. TVA also fails to evaluate the effects of discharge temperatures on fish eggs and larvae, which are much more vulnerable to thermal discharge than adult fish because these early

life stages have lower tolerance for increased water temperatures, compared to their adult stages and lack the mobility to avoid high temperatures. Outfall 113 (SCCW) maximum thermal discharge temperature is stated as >90°F from April – September. This temperature kills the early life history stages (eggs and larvae) of several important game fish that would be found near WBN including largemouth bass (Stuber et al. 1982) and striped bass (Bain and Bain 1982; Fay et al. 1983), and likely causes mortality in many less-studied and less-desired yet important non-game fish species. However, TVA only discusses potential mortality to adult fish and mussels (2008 TVA RAI Response Section 3.3.3.3, Pages 36 – 39).

e. TVA relies on the temperature at the edge of the thermal discharge plume, or mixing zone, to evaluate impacts to aquatic organisms. This approach yields misleading and inaccurate results, because organisms drifting through the core of the mixing zones nearest the outfall diffusers will encounter the higher temperature of the thermal discharge as it is first released and before mixing occurs to dissipate the waste heat.

f. TVA does not address the potential impacts from variability in the size and perimeter of the mixing zone changing as Watts Bar Dam discharge changes on an hourly, daily, and seasonal basis. The potential daily variation of the mixing zone configuration expanding from half the river channel to the full river channel may have a large affect on aquatic organisms.

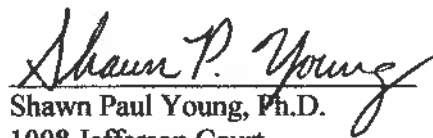
4. According to FSEIS 2.2.2 page 23, Outfall 101 may be closed at < 3500 cfs discharge from Watts Bar Dam. The thermal effluent that ordinarily would be released from Outfall 101 would therefore be stored in holding ponds on-site. If pond storage capacity is exceeded, WBN would discharge a large quantity of water from emergency holding ponds (Outfall 102) at temperatures allowable up to 104°F into a local stream channel. In such a case, the temperature of the discharge would likely kill all fish and mussels in the receiving stream, and potentially

impact fish and mussels in the reservoir near the stream confluence with Chickamauga Reservoir. No data on fish or mussel species in the receiving stream are listed anywhere in the FSEIS. Although this scenario has not occurred, this should be addressed given the elevated risk of increased thermal discharge volume with operating two units instead of one, and especially given the number of sensitive aquatic species in the vicinity of WBN. TVA would be responsible for only performing thermal surveys of the effluent behavior in the river after such an event. TVA does not address the likelihood of high mortality to fish and mussels as a result of such an event, and after-the-fact studies would be too late to protect any sensitive and rare species.

F. TVA Does not Adequately Address Cumulative Impacts

1. In Section 3.0 of the FSEIS, TVA states that cumulative impacts were considered (page 3.0). But the FSEIS does not contain the discussion that I would expect to see regarding the combined contribution of the WBN2 cooling system, taken together with other industrial activities on Chickamauga Reservoir and the effect of the various impoundments of the Tennessee River.
2. As discussed above, the state of the health of the aquatic biota in the Tennessee River, including the Chickamauga Reservoir, is fragile and declining. Each additional impact threatens to push more species of fish and benthic organisms over the edge into extinction, and makes it more difficult to restore the health of the ecosystem. Yet, TVA has given virtually no attention to these cumulative impacts, or to ways they could be mitigated.

Under penalty of perjury, I declare that the foregoing facts are true and correct to the best of my knowledge, and that the expressions of opinion are based on my best professional judgment.


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Dated: July 11, 2009

Literature Cited

- Angermeier, P. L. 1995. Ecological attributes of extinction-prone species: Loss of freshwater fishes of Virginia. *Conservation Biology* 9(1): 143-158.
- Bain, M. B., and J. L. Bain. 1982. Habitat suitability index models: coastal stocks of striped bass. U.S. Fish and Wildlife Service, Office of Biological Services, Washington, D.C. FWS/OBS-82/10.1. 29 pp.
- Etnier, D.A. & Starnes, W.C. 1993. The fishes of Tennessee. Knoxville, TN: The University of Tennessee Press. 704 pp.
- Fay, C. W., R. J. Neves, and G. B. Pardue. 1983. Species profiles: Life histories and environmental requirements of coastal fishes and invertebrates (Mid-Atlantic) – striped bass. U.S. Fish and Wildlife, Division of Biological Services, FWSOBS-82/11.8. U.S. Army Corps of Engineers, TR EL-82-4. 36 pp.
- Hampson, P.S., Treece, M.W. Jr., Johnson, G.C., Ahlstedt, S.A., and Connell, J.F., 2000, Water Quality in the Upper Tennessee River Basin, Tennessee, North Carolina, Virginia, and Georgia 1994–98: U.S. Geological Survey Circular 1205, 32 p., on-line at <http://pubs.water.usgs.gov/circ1205/>.
- Marcy, B. C., D. E. Fletcher, F. D. Martin, M. H. Paller, and M. Reichert. 2005. Fishes of the Middle Savannah River Basin. The University of Georgia Press. Athens, GA. 460 pp.
- Master, L. L., S. R. Flack, and B. A. Stein. 1998. Rivers of life: Critical watersheds for protecting freshwater biodiversity. The Nature Conservancy, Arlington, Virginia.
- Parmalee, P. W., and A. E. Bogan. 1998. The freshwater mussels of Tennessee. University of Tennessee Press, Knoxville, TN. 328 pp.
- Pflieger, W.L. 1975. The fishes of Missouri. Jefferson City, MO: Missouri Department of Conservation. 372 pp.
- Rohde, F. C., R. G. Arndt, D. G. Lindquist, and J. F. Parnell. 1994. Freshwater fishes of the Carolinas, Virginia, Maryland and Delaware. University of North Carolina Press, Chapel Hill, North Carolina.
- Simon, T. P., and R. Wallus. 2006. Reproductive biology and early life history of fishes in the Ohio River drainage. Taylor and Francis Group, Boca Raton, Florida.
- Starnes, L. B., and A. E. Bogan. 1988. The mussels (Mollusca: Bivalvia: Unionidae) of Tennessee. *American Malacological Bulletin* 6(1): 19-37.
- Stuber, R. J., G. Gebhart, and O. E. Maughan. 1982. Habitat suitability index models: Largemouth bass. U.S. Dept. Int. Fish Wildl. Serv. FWS/OBS-82/10.16. 32 pp.

U. S. Environmental Protection Agency. 1977. Guidance for evaluating the adverse impact of cooling water intake structures on the aquatic environment: Section 316(b) P. L. 92-500.

Vaughan, C. 1997. Regional patterns of mussel species distributions in North American rivers. *Ecography* 20:107-115.

http://www.tva.com/sites/sites_ie2.htm

<http://www.nrc.gov/reactors/new-reactors/col/new-reactor-map.html>